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CONTENTS

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Continued on page three of cover.

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LIST OF MEETINGS AND PAST OFFICERS

First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; First Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 17–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wis., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President, W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty-eighth Annual Meeting.)

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27–30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President, W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-ninth Annual Meeting, New York, N. Y., Dec. 28–30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

LIST OF MEMBERS

ACTIVE MEMBERS

Ainslie, C. N., 5205 Morningside Ave., Sioux City, Iowa.
Aldrich, J. M., U. S. Bureau of Entomology, West Lafayette, Ind.
Back, E. A., U. S. Bureau of Entomology, Washington, D. C.
Baker, C. F., Los Banos, Philippine Islands.
Ball, E. D., State Capitol, Madison, Wis.
Banks, C. S., Bureau of Science, Manila, P. I.
Banks, Nathan, Museum of Comparative Zoölogy, Cambridge, Mass.
Barber, H. S., U. S. Bureau of Entomology, Washington, D. C.
Bentley, G. M., University of Tennessee, Knoxville, Tenn.
Berger, E. W., University of Florida, Gainesville, Fla.
Bethune, C. J. S., Guelph, Ontario, Canada.
Bishopp, F. C., U. S. Bureau of Entomology, Dallas, Texas.
Britton, W. E., Agricultural Experiment Station, New Haven, Conn.
Brooks, F. E., U. S. Bureau of Entomology, French Creek, W. Va.
Brues, C. T., Bussey Institution, Forest Hills, Boston, Mass.
Bruner, Lawrence, Agricultural Experiment Station, Lincoln, Neb.
Burgess, A. F., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Burke, H. E., Los Gatos, Cal.
Busck, August, U. S. National Museum, Washington, D. C.
Caesar, Lawson, Ontario Agricultural College, Guelph, Canada.
Caudell, A. N., U. S. National Museum, Washington, D. C.
Chittenden, F. H., U. S. Bureau of Entomology, Washington, D. C.
Cockerell, T. D. A., Boulder, Colo.
Collins, C. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Comstock, J. H., Cornell University, Ithaca, N. Y.
Conradi, A. F., Clemson College, S. C.
Cook, Mel. T., Agricultural Experiment Station, New Brunswick, N. J.
Cooley, R. A., Agricultural Experiment Station, Bozeman, Mont.
Cotton, E. C., R. F. D. 4, Elyria, Ohio.
Crawford, J. C., U. S. National Museum, Washington, D. C.
Crosby, C. R., Cornell University, Ithaca, N. Y.
Davis, J. J., U. S. Bureau of Entomology, Lafayette, Ind.
Dean, George A., Agricultural Experiment Station, Manhattan, Kan.
Ehrhorn, E. M., Honolulu, H. T.
Essig, E. O., University of California, Berkeley, Cal.
Felt, E. P., State Museum, Albany, N. Y.
Fernald, C. H., Agricultural College, Amherst, Mass.
Fernald, H. T., Agricultural College, Amherst, Mass.
Fiske, W. F., South Hanson, Mass.
Forbes, S. A., University of Illinois, Urbana, Ill.
Foster, S. W., 201 Sansome St., San Francisco, Cal.
Franklin, H. J., East Wareham, Mass.
Fullaway, D. T., Agricultural Experiment Station, Honolulu, H. T.
Fulton, B. B., Agricultural Experiment Station, Geneva, N. Y.
Gahan, A. B., College Park, Md.
Garman, H., Agricultural Experiment Station, Lexington, Ky.
Gates, B. N., Agricultural Experiment Station, Amherst, Mass.

Gibson, Arthur, Entomological Branch, Ottawa, Canada.
Gillette, C. P., Agricultural Experiment Station, Fort Collins, Colo.
Goodwin, W. H., Agricultural Experiment Station, Wooster, Ohio.
Gossard, H. A., Agricultural Experiment Station, Wooster, Ohio.
Harned, R. W., Agricultural College, Miss.
Hart, C. A., Illinois State Laboratory of Natural History, Urbana, Ill.
Hartzell, F. Z., Agricultural Experiment Station, Geneva, N. Y.
Headlee, T. J., Agricultural Experiment Station, New Brunswick, N. J.
Herms, W. B., University of California, Berkeley, Cal.
Herrick, Glenn W., Cornell University, Ithaca, N. Y.
Hewitt, C. Gordon, Dominion Entomologist, Ottawa, Canada.
Hinds, W. E., Agricultural Experiment Station, Auburn, Ala.
Hine, J. S., Ohio State University, Columbus, Ohio.
Hodgkiss, H. E., Agricultural Experiment Station, Geneva, N. Y.
Holland, W. J., Carnegie Museum, Pittsburgh, Pa.
Hooker, W. A., Office of Experiment Stations, Washington, D. C.
Hopkins, A. D., U. S. Bureau of Entomology, Washington, D. C.
Houghton, C. O., Agricultural Experiment Station, Newark, Del.
Houser, J. S., Agricultural Experiment Station, Wooster, Ohio.
Howard, C. W., University Farm, St. Paul, Minn.
Howard, L. O., U. S. Bureau of Entomology, Washington, D. C.
Hunter, S. J., University of Kansas, Lawrence, Kan.
Hunter, W. D., U. S. Bureau of Entomology, Washington, D. C.
Hyslop, J. A., U. S. Bureau of Entomology, Hagerstown, Md.
Jennings, A. H., U. S. Bureau of Entomology, Washington, D. C.
Johannsen, O. A., Cornell University, Ithaca, N. Y.
Johnson, S. A., Agricultural Experiment Station, Fort Collins, Colo.
Jones, P. R., 350 California St., San Francisco, Cal.
Kellogg, V. L., Stanford University, Cal.
Kelly, E. O. G., U. S. Bureau of Entomology, Wellington, Kan.
Kincaid, Trevor, University of Washington, Seattle, Wash.
Kotinsky, J., U. S. Bureau of Entomology, Washington, D. C.
Lochhead, Wm., Macdonald College of Agriculture, Montreal, Canada.
MacGillivray, A. D., University of Illinois, Urbana, Ill.
Marlatt, C. L., U. S. Bureau of Entomology, Washington, D. C.
McColloch, J. W., Agricultural Experiment Station, Manhattan, Kan.
McGregor, E. A., U. S. Bureau of Entomology, El Centro, Cal.
Merrill, J. H., Agricultural Experiment Station, Manhattan, Kan.
Metcalf, C. L., Ohio State University, Columbus, Ohio.
Morgan, A. C., U. S. Bureau of Entomology, Clarksville, Tenn.
Morgan, H. A., Agricultural Experiment Station, Knoxville, Tenn.
Morrill, A. W., Phoenix, Ariz.
Newell, Wilmon, State Plant Commission, Gainesville, Fla.
O'Kane, W. C., Agricultural Experiment Station, Durham, N. H.
Osborn, Herbert, Ohio State University, Columbus, Ohio.
Paddock, F. B., College Station, Texas.
Parker, J. R., Agricultural Experiment Station, Bozeman, Mont.
Parrott, P. J., Agricultural Experiment Station, Geneva, N. Y.
Patch, Edith M., Agricultural Experiment Station, Orono, Me.
Peairs, L. M., 5465 Greenwood Ave., Chicago, Ill.
Perkins, R. C. L., Derwent, Cleveland Rd., Paignton, England.
Pettit, Morley, Agricultural College, Guelph, Canada.

Pettit, R. H., Agricultural Experiment Station, East Lansing, Mich.
Phillips, E. F., U. S. Bureau of Entomology, Washington, D. C.
Phillips, W. J., U. S. Bureau of Entomology, Charlottesville, Va.
Pierce, W. D., U. S. Bureau of Entomology, Washington, D. C.
Quaintance, A. L., U. S. Bureau of Entomology, Washington, D. C.
Quayle, H. J., University of California, Berkeley, Cal.
Reeves, George I., U. S. Bureau of Entomology, Salt Lake City, Utah.
Riley, W. A., Cornell University, Ithaca, N. Y.
Ruggles, A. G., Agricultural Experiment Station, St. Anthony Park, Minn.
Rumsey, W. E., Agricultural Experiment Station, Morgantown, W. Va.
Sanders, J. G., Economic Zoölogist, Harrisburg, Pa.
Sanderson, E. D., 1109 East 54 Place, Chicago, Ill.
Sasscer, E. R., U. S. Bureau of Entomology, Washington, D. C.
Schoene, W. J., Agricultural Experiment Station, Blacksburg, Va.
Schwarz, E. A., U. S. National Museum, Washington, D. C.
Scott, E. W., U. S. Bureau of Entomology, Vienna, Va.
Shafer, G. D., Agricultural Experiment Station, East Lansing, Mich.
Sherman, Franklin, Jr., State Department of Agriculture, Raleigh, N. C.
Skinner, Henry, Logan Square, Philadelphia, Pa.
Smith, H. S., State Insectary, Sacramento, Cal.
Smith, R. I., 6 Beacon St., Boston, Mass.
Stedman, J. M., Office of Experiment Stations, Washington, D. C.
Summers, H. E., Agricultural Experiment Station, Ames, Iowa.
Surface, H. A., Department of Agriculture, Harrisburg, Pa.
Swaine, J. M., Entomological Branch, Ottawa, Canada.
Swenk, M. H., Agricultural Experiment Station, Lincoln, Neb.
Swezey, O. H., Hawaiian Sugar Planters' Experiment Station, Honolulu, H. T.
Symons, T. B., Agricultural Experiment Station, College Park, Md.
Taylor, E. P., University of Arizona, Tucson, Ariz.
Timberlake, P. H., Sugar Planters' Experiment Station, Honolulu, H. T.
Titus, E. G., Agricultural Experiment Station, Logan, Utah.
Townsend, C. H. T., U. S. Bureau of Entomology, Washington, D. C.
Troop, James, Agricultural Experiment Station, Lafayette, Ind.
Van Dine, D. L., U. S. Bureau of Entomology, Washington, D. C.
Viereck, H. L., Bureau Biological Survey, Washington, D. C.
Walden, B. H., Agricultural Experiment Station, New Haven, Conn.
Walton, W. R., U. S. Bureau of Entomology, Washington, D. C.
Washburn, F. L., Agricultural Experiment Station, St. Anthony Park, Minn.
Webb, J. L., U. S. Bureau of Entomology, Washington, D. C.
Webster, R. L., Agricultural Experiment Station, Ames, Iowa.
Weldon, G. P., Commissioner of Horticulture, Sacramento, Cal.
Wheeler, W. M., Bussey Institution, Forest Hills, Boston, Mass.
Wildermuth, V. L., U. S. Bureau of Entomology, Tempe, Ariz.
Wilson, H. F., University of Wisconsin, Madison, Wis.
Woglum, R. S., 824 N. Curtis Ave., Alhambra, Cal.
Worsham, E. L., Capitol Building, Atlanta, Ga.
Yothers, W. W., U. S. Bureau of Entomology, Orlando, Fla.

ASSOCIATE MEMBERS

Abbott, W. S., U. S. Bureau of Entomology, Vienna, Va.
Ackerman, A. J., U. S. Bureau of Entomology, Washington, D. C.
Ainslie, George G., R. R. 9, Knoxville, Tenn.

Allen, H. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Anderson, G. M., Tallulah, La.
Atwood, George G., State Department of Agriculture, Albany, N. Y.
Ayres, Ed L., Capitol Station, Austin, Texas.
Babcock, O. G., R. 2, Knoll Ranch, Berthand, Colo.
Backus, H. E., North East, Pa.
Baerg, W. J., Cornell University, Ithaca, N. Y.
Bailey, I. L., Northboro, Mass.
Bailey, J. W., Agricultural College, Miss.
Baker, A. C., U. S. Bureau of Entomology, Washington, D. C.
Baker, A. W., Ontario Agricultural College, Guelph, Canada.
Baldwin, C. H., Indianapolis, Ind.
Barber, E. R., U. S. Bureau of Entomology, Audubon Park, New Orleans, La.
Barber, G. W., U. S. Bureau of Entomology, Wellington, Kan.
Barber, T. C., Tucuman, Argentina.
Barnes, P. T., 1726 Regina St., Harrisburg, Pa.
Barnes, Wm., Decatur, Ill.
Barrett, E. L., U. S. Bureau of Entomology, Wellington, Kan.
Bartlett, O. C., Phoenix, Ariz.
Becker, G. G., Agricultural Experiment Station, Fayetteville, Ark.
Bensel G. E., Oxnard, Cal.
Beutenmuller, Wm., 879 Whitlock Ave., Bronx, N. Y.
Beyer, A. H., U. S. Bureau of Entomology, Columbia, S. C.
Bilsing, S. W., Agricultural and Mechanical College, College Station, Texas.
Blackman, M. W., N. Y. State College of Forestry, Syracuse, N. Y.
Blakeslee, E. B., U. S. Bureau of Entomology, Washington, D. C.
Bourne, A. I., Agricultural Experiment Station, Amherst, Mass.
Bower, L. J., U. S. Bureau of Entomology, Salt Lake City, Utah.
Bradley, J. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Braucher, R. W., Kent, Ohio.
Buck, J. E., Rural Retreat, Va.
Burrill, A. C., University of Idaho, Moscow, Idaho.
Caffrey, Donald J., U. S. Bureau of Entomology, Tempe, Ariz.
Campbell, R. E., Box F, Station B, Pasadena, Cal.
Cardin, P. G., Santiago de las Vegas, Cuba.
Chamberlin, T. R., 1718 Elizabeth St., Salt Lake City, Utah.
Champlain, A. B., Colorado Springs, Colo.
Chandler, W. L., 202 Delaware Ave., Ithaca, N. Y.
Chapman, J. W., Silliman Institute, Dumagueta, P. I.
Chapman, R. N., Pierce St., St. Paul, Minn.
Chase, W. W., Capitol Building, Atlanta, Ga.
Childs, Leroy, Hood River, Ore.
Christie, Jesse R., Maryland Agricultural College, College Park, Md.
Chrystal, R. N., Entomological Branch, Ottawa, Canada.
Claason, P. W., 1614 Ky. St., Lawrence, Kan.
Clapp, S. C., State Department of Agriculture, Raleigh, N. C.
Cleveland, C. R., Agricultural Experiment Station, Durham, N. H.
Coad, B. R., U. S. Bureau of Entomology, Tallulah, La.
Coe, Wesley R., Yale University, New Haven, Conn.
Cole, F. R., 402 M St., N. W., Washington, D. C.
Coleman, G. A., Agricultural Hall, University of California, Berkeley, Cal.
Corbett, G. H., The Gretna, Trowbridge, Wiltshire, England.

Cory, E. N., Agricultural Experiment Station, College Park, Md.
Cotton, R. T., Insular Experiment Station, Rio Piedras, P. R.
Couden, F. D., South Bend, Washington.
Courtney, O. K., College Station, Texas.
Crampton, G. C., Agricultural College, Amherst, Mass.
Crawford, D. L., Pomona College, Claremont, Cal.
Crawford, H. G., 505 First St., Champaign, Ill.
Creel, C. W., U. S. Bureau of Entomology, Forest Grove, Ore.
Criddle, Norman, Treesbank, Manitoba, Canada.
Crossman, S. S., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Culver, J. J., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Currie, R. P., U. S. Bureau of Entomology, Washington, D. C.
Cushman, R. A., U. S. Bureau of Entomology, Washington, D. C.
Davidson, Wm., State Insectary, Sacramento, Cal.
Davis, I. W., Agricultural Experiment Station, New Haven, Conn.
Dew, J. A., Mobile, Ala.
Dickerson, E. L., 106 Prospect St., Nutley, N. J.
Dietz, H. F., Federal Horticultural Board, Washington, D. C.
Doane, R. W., Stanford University, Cal.
Dohanian, S. M., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Douglass, B. W., Trevlac, Ind.
Dove, W. E., U. S. Bureau of Entomology, Dallas, Texas.
Duckett, A. B., Bladensburg, Md.
Dudley, J. E., Jr., U. S. Bureau of Entomology, Vienna, Va.
Dusham, E. H., State College, Pa.
Eagerton, H. C., Agricultural Experiment Station, Marion, S. C.
Eddy, M. W., Pa. State College, State College, Pa.
Ellis, W. O., College of Forestry, Syracuse, N. Y.
Emery, W. T., U. S. Bureau of Entomology, Charlottesville, Va.
Engle, E. B., Office State Zoölogist, Harrisburg, Pa.
Evans, Wm. E., Jr., Painesville, Ohio.
Ewing, H. E., Station A, Ames, Iowa.
Farrar, Edward R., South Lincoln, Mass.
Fenton, F. A., U. S. Bureau of Entomology, West Lafayette, Ind.
Fink, D. E., U. S. Bureau of Entomology, Norfolk, Va.
Fisher, W. S., U. S. National Museum, Washington, D. C.
Fiske, R. J., U. S. Bureau of Entomology, Washington, D. C.
Flint, W. P., 1231 W. Edwards St., Springfield, Ill.
Fox, Henry, U. S. Bureau of Entomology, Clarksville, Tenn.
Fracker, S. B., State Capitol, Madison, Wis.
Garman, Philip, College Park, Md.
Garrett, J. B., Agricultural Experiment Station, Baton Rouge, La.
Gates, F. H., U. S. Bureau of Entomology, Tempe, Ariz.
Gentner, L. G., University of Wisconsin, Madison, Wis.
Gibson, E. H., U. S. Bureau of Entomology, R. R. 1, Alexandria, Va.
Giffard, W. M., Box 308, Honolulu, H. T.
Gill, John B., U. S. Bureau of Entomology, Washington, D. C.
Glasgow, Hugh, Agricultural Experiment Station, Geneva, N. Y.
Glenn, P. A., Office of State Entomologist, Urbana, Ill.
Goodwin, James C., Box 138, Gainesville, Fla.
Gowdey, C. C., Entebbe, Uganda, East Africa.
Graf, J. E., Drawer G, Station B, Pasadena, Cal.

Gram, Ernst, Cosmopolitan Club, Ithaca, N. Y.
Green, E. C., 923 W. Green St., Urbana, Ill.
Gregson, P. B., Canvey Island, South Benfleet, Essex, England.
Hadley, Charles H., Jr., State College, Pa.
Hagan, H. R., Bussey Institution, Forest Hills, Mass.
Hamilton, C. C., Cornell University, Ithaca, N. Y.
Hardenberg, C. B., Box 434, Pretoria, Transvaal, South Africa.
Hargreaves, Ernest, 70 Oak Mount, Burley, Lancashire, England.
Harrington, W. H., 295 Gilmour St., Ottawa, Canada.
Harvey, B. T., U. S. Bureau of Entomology, Box 1377, Missoula, Mont.
Haseman, Leonard, Agricultural Experiment Station, Columbia, Mo.
Hasey, W. H., 34 Market St., Campello, Mass.
Hawley, I. M., 1142 Broadway, Indianapolis, Ind.
Hayes, W. P., Agricultural Experiment Station, Manhattan, Kan.
Hertzog, P. M., Hightstown, N. J.
High, M. M., U. S. Bureau of Entomology, Brownsville, Texas.
Hill, C. C., R. R. 9, Knoxville, Tenn.
Hodge, C. F., 125 Buffalo Ave., Takoma Park, D. C.
Hollinger, A. H., Agricultural Experiment Station, Columbia, Mo.
Hollister, W. O., Kent, Ohio.
Holloway, T. E., U. S. Bureau of Entomology, Aubudon Park, La.
Hood, C. E., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Hood, J. D., Biological Survey, Washington, D. C.
Horton, J. R., U. S. Bureau of Entomology, Washington, D. C.
Howard, N. F., College of Agriculture, Madison, Wis.
Howe, R. W., Wilmington, Vt.
Hudson, G. H., Plattsburg, N. Y.
Hungerford, H. B., Cornell University, Ithaca, N. Y.
Hutson, J. C., Department of Agriculture, Barbadoes, B. W. I.
Illingworth, J. F., College of Hawaii, Honolulu, H. T.
Isely, Dwight, U. S. Bureau of Entomology, Washington, D. C.
Jewett, H. H., 424 Linden Walk, Lexington, Ky.
Jones, Charles R., Agricultural College, Fort Collins, Colo.
Jones, D. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Jones, T. H., U. S. Bureau of Entomology, Baton Rouge, La.
Kephart, Cornelia F., Cornell University, Ithaca, N. Y.
Kewley, R. J., U. S. Bureau of Entomology, College Park, Md.
Kidder, Nathaniel T., Milton, Mass.
King, J. L., 3233 Carnegie Ave., Cleveland, Ohio.
King, Vernon, U. S. Bureau of Entomology, Wellington, Kan.
King, W. V., Box 770, New Orleans, La.
Kirk, H. B., 1851 Herr St., Harrisburg, Pa.
Kisliuk, Max, Jr., 1424 6th St., N. W., Washington, D. C.
Knab, Frederick, U. S. National Museum, Washington, D. C.
Knight, H. H., Cornell University, Ithaca, N. Y.
Koebele, Albert, Waldkirch i. Br., Baden, Germany.
Kraus, E. J., Agricultural Experiment Station, Corvallis, Ore.
Laake, E. W., U. S. Bureau of Entomology, Dallas, Texas.
Lamson, G. H., Jr., Agricultural College, Storrs, Conn.
Larrimer, W. H., U. S. Bureau of Entomology, Charleston, Mo.
Lathrop, F. H., Agricultural Experiment Station, Geneva, N. Y.
Lauderdale, J. L. E., 557 3d St., Baton Rouge, La.

Ledyard, E. M., Salt Lake City, Utah.
Leiby, R. W., State Department of Agriculture, Raleigh, N. C.
Leonard, M. D., Cornell University, Ithaca, N. Y.
Lewis, A. C., Capitol Building, Atlanta, Ga.
Littler, F. M., 65 High St., Launceston, Tasmania.
Loftin, U. C., U. S. Bureau of Entomology, Aubudon Park, La.
Loveland, C. W., Satsuma Heights, Fla.
Lovett, A. L., Agricultural College, Corvallis, Ore.
Lowry, Q. S., Agricultural Experiment Station, New Haven, Conn.
Luginbill, Philip, U. S. Bureau of Entomology, Columbia, S. C.
Mann, B. P., 1918 Sunderland Pl., Washington, D. C.
Manter, J. A., Conn. Agricultural College, Storrs, Conn.
Marcovitch, Simon, University Farm, St. Paul, Minn.
Marsh, H. O., U. S. Bureau of Entomology, Rocky Ford, Colo.
Marshall, W. W., Agricultural and Mechanical College, College Station, Texas.
Martin, J. F., Agricultural College, Amherst, Mass.
Mason, A. C., State Plant Board, Gainesville, Fla.
Mason, P. W., Purdue University, Lafayette, Ind.
Mason, S. L., Box 95, West Lafayette, Ind.
Matheson, Robert, Cornell University, Ithaca, N. Y.
Maxon, Asa C., Longmont, Colo.
McConnell, W. R., U. S. Bureau of Entomology, Hagerstown, Md.
McDaniel, Eugenia, Agricultural College, East Lansing, Mich.
McDonough, F. L., U. S. Bureau of Entomology, Clarksville, Tenn.
McGehee, T. F., Tallulah, La.
McLaine, L. S., care of Dominion Entomologist, Ottawa, Canada.
McMillan, D. K., 5057 Balmoral Ave., Chicago, Ill.
Melander, A. L., Agricultural College, Pullman, Wash.
Menagh, C. S., U. S. Bureau of Entomology, Washington, D. C.
Mendenhall, E. W., 97 Brighton Rd., Columbus, Ohio.
Merrill, G. B., care of State Plant Commission, Gainesville, Fla.
Metcalf, Z. P., Agricultural Experiment Station, West Raleigh, N. C.
Miles, P. B., 1265 Kensington Ave., Salt Lake City, Utah.
Millen, F. E., East Lansing, Mich.
Milliken, F. B., 214 N. Clarence Ave., Wichita, Kan.
Minott, C. W., Hudson, Mass.
Moore, Wm., University Farm, St. Paul, Minn.
Moreland, R. W., Tallulah, La.
Morris, E. L., San Jose, Cal.
Morrison, Harold, Federal Horticultural Board, Washington, D. C.
Morse, A. P., Wellesley, Mass.
Mosher, F. H., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Moznette, G. F., Agricultural College, Corvallis, Ore.
Muesebeck, C. F. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Myers, P. R., U. S. Bureau of Entomology, Hagerstown, Md.
Nelson, J. A., U. S. Bureau of Entomology, Washington, D. C.
Ness, Henry, Ames, Iowa.
Neüls, J. D., 815 Dos Robles Pl., Alhambra, Cal.
Niswonger, H. R., Agricultural Experiment Station, Lexington, Ky.
Nougaret, R. L., U. S. Bureau of Entomology, Fresno, Cal.
O'Byrne, F. M., Gainesville, Fla.
Oestlund, O. W., University of Minnesota, Minneapolis, Minn.

Osborn, Herbert T., Hawaiian Sugar Planters' Experiment Station, Honolulu, H. T.
Osgood, W. A., N. H. College, Durham, N. H.
Packard, C. M., Martinez, Cal.
Paine, C. T., Redlands, Cal.
Paine, J. H., U. S. Bureau of Entomology, Washington, D. C.
Parker, H. L., U. S. Entomological Laboratory, Hagerstown, Md.
Parker, R. R., Agricultural College, Bozeman, Mont.
Parks, T. H., Extension Division, Manhattan, Kan.
Parman, D. C., U. S. Bureau of Entomology, Uvalde, Texas.
Peake, G. W., University Farm, St. Paul Minn.
Pellett, F. C., Atlantic, Iowa.
Pemberton, C. E., U. S. Bureau of Entomology, Honolulu, H. T.
Pennington, W. E., U. S. Bureau of Entomology, Hagerstown, Md.
Peterson, Alvah, Entomology Building, New Brunswick, N. J.
Philbrook, E. E., Portland, Me.
Phillips, Saul, Beverly, Mass.
Pierson, C. J., College Park, Md.
Plank, H. K., U. S. Bureau of Entomology, Washington, D. C.
Popenoe, C. H., U. S. Bureau of Entomology, Washington, D. C.
Powers, E. B., University of Illinois, Urbana, Ill.
Preston, H. A., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Rane, F. W., 6 Beacon St., Boston, Mass.
Reed, E. B., Victoria, Canada.
Reed, W. V., Capitol Building, Atlanta, Ga.
Regan, W. S., 84 Pleasant St., Amherst, Mass.
Reinhard, H. J., College Station, Texas.
Richardson, C. H., 1400 University Ave., New York City.
Ricker, D. A., Station A, Ames, Iowa.
Ripley, E. P., Weston, Mass.
Rockwood, L. P., U. S. Bureau of Entomology, Forest Grove, Ore.
Rogers, D. M., U. S. Bureau of Entomology, 43 Tremont St., Boston, Mass.
Rolfs, P. H., Agricultural Experiment Station, Gainesville, Fla.
Rosewall, O. W., Louisiana State University, Baton Rouge, La.
Runner, G. A., 56 Stafford St., Clarksville, Tenn.
Safro, V. I., Louisville, Ky.
Sanders, G. E., care of Dominion Entomologist, Ottawa, Canada.
Sanford, H. L., U. S. Bureau of Entomology, Washington, D. C.
Satterthwait, A. F., U. S. Bureau of Entomology, Lafayette, Ind.
Scammell, H. B., U. S. Bureau of Entomology, Washington, D. C.
Schaffner, J. V., Jr., Dover, Mass.
Scholl, E. E., Capitol Building, Austin, Texas.
Scott, C. L., U. S. Bureau of Entomology, Wellington, Kan.
Scott, W. M., Office of Markets, Department of Agriculture, Washington, D. C.
Seamans, H. L., State College, Bozeman, Mont.
Seigler, E. H., U. S. Bureau of Entomology, Washington, D. C.
Severin, H. C., Agricultural Experiment Station, Brookings, S. D.
Shaw, N. E., State Department of Agriculture, Columbus, Ohio.
Shelford, V. E., University of Illinois, Urbana, Ill.
Simanton, F. L., U. S. Bureau of Entomology, Washington, D. C.
Smith, G. A., State Forester's Office, State House, Boston, Mass.
Smith, H. E., U. S. Bureau of Entomology, West Springfield, Mass.
Smith, L. B., Blacksburg, Va.

Smith, L. M., Natural History Building, Urbana, Ill.
Smulyan, M. T., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Snow, S. J., U. S. Bureau of Entomology, Salt Lake City, Utah.
Snyder, T. E., U. S. Bureau of Entomology, Washington, D. C.
Somes, M. P., 89 Victoria St., St. Paul, Minn.
Spangler, A. J. Montclair Station, Denver, Colo.
Speaker, H. J., Sandusky, Ohio.
Spooner, Charles, Capitol Building, Atlanta, Ga.
Stafford, E. W., 1985 Selby Ave., St. Paul, Minn.
Stene, A. E., Agricultural Experiment Station, Kingston, R. I.
Stockwell, C. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Strickland, E. H., Entomological Branch, Ottawa, Canada.
Summers, J. N., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Swain, A. F., Court House, San Diego, Calif.
Talbert, T. J., Columbia, Mo.
Taylor, J. Edward, State Capitol, Salt Lake City, Utah.
Thomas, F. L., Auburn, Ala.
Thomas, W. A., Clemson College, S. C.
Thompson, W. R., The Museums, Cambridge, England.
Tothill, J. D., Fredrickton, N. B.
Tower, D. G., Federal Horticultural Board, Washington, D. C.
Tower, W. V., Department of Agriculture, San Juan, P. R.
Tsou, Y. H., University of Nanking, Nanking, China.
Turner, C. F., U. S. Bureau of Entomology, Greenwood, Miss.
Turner, W. B., U. S. Bureau of Entomology, Hagerstown, Md.
Turner, W. F., U. S. Bureau of Entomology, Vienna, Va.
Urbahns, T. D., 150 S. Hollister Ave., Pasadena, Cal.
Van Dyke, E. C., University of California, Berkeley, Cal.
VanZwalenwenberg, R. H., Agricultural Experiment Station, Mayaguez, P. R.
Vaughan, E. A., Agricultural Experiment Station, Auburn, Ala.
Vausell, G. A., University of Kentucky, Lexington, Ky.
Vickery, R. A., U. S. Bureau of Entomology, Brownsville, Texas.
Wade, Joe S., U. S. Bureau of Entomology, Wellington, Kan.
Webber, R. T., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Weed, C. M., State Normal School, Lowell, Mass.
Weiss, H. B., Agricultural Experiment Station, New Brunswick, N. J.
Wellhouse, Walter, University of Kansas, Lawrence, Kan.
Whelan, Don B., Box 804, East Lansing, Mich.
White, W. H., College Park, Md.
Whitmarsh, R. D., Agricultural Experiment Station, Wooster, Ohio.
Williams, C. B., The Horticultural Institution, Merton, Surry, England.
Williamson, Warren, Agricultural Experiment Station, St. Anthony Park, Minn.
Wilson, R. N., U. S. Bureau of Entomology, Gainesville, Fla.
Wilson, T. S., U. S. Bureau of Entomology, Wellington, Kan.
Wiltberger, P. B., University of Maine, Orono, Me.
Windle, Francis, West Chester, Pa.
Winslow, R. M., Department of Agriculture, Victoria, Canada.
Wolcott, G. N., 311 E. Green St., Champaign, Ill.
Wood, H. P., U. S. Bureau of Entomology, Dallas, Texas.
Wood, W. B., U. S. Bureau of Entomology, Washington, D. C.
Woodin, G. C., 179 S. Richardson Ave., Columbus, Ohio.
Woods, W. C., Agricultural Experiment Station, Orono, Me.

Wooldridge, Reginald, U. S. Bureau of Entomology, Melrose Highlands, Mass.
Worthley, L. H., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Yothers, M. A., Agricultural Experiment Station, Pullman, Wash.
Young, D. B., State Museum, Albany, N. Y.
Zappe, Max P., Agricultural Experiment Station, New Haven, Conn.

FOREIGN MEMBERS

Anderson, T. G., Nairobi, British East Africa.
Ballou, H. A., Imperial Department of Agriculture, Barbados, West Indies.
Berlese, Dr. Antonio, Reale Stazione di Entomologia Agraria, Firenze, Italy.
Bordage, Edmond, Directeur de Musée, St. Denis, Reunion.
Carpenter, Dr. George H., Royal College of Science, Dublin, Ireland.
Cholodkovsky, Prof. Dr. N., Militär-Medicinische Akademie, Petrograd, Russia.
Collinge, W. E., 55 Newhall Street, Birmingham, England.
Danysz, J., Laboratoire de Parasitologie, Bourse de Commerce, Paris, France.
DeBussy, L. P., Deli, Sumatra.
Enock, Fred, 42 Salisbury Road, Bexley, London, S. E., England.
Escherisch, K., Forstliche Versuchsaustalt, Universitat, Munich, Germany.
French, Charles, Department of Agriculture, Melbourne, Australia.
Froggatt, W. W., Department of Agriculture, Sydney, New South Wales.
Fuller, Claude, Department of Agriculture, Peitermaritzburg, Natal, South Africa.
Gillanders, A. T., Alnwick, Northumberland, England.
Goding, F. W., Guayaquil, Equador, South America.
Grasby, W. C., 6 West Australian Chambers, Perth, West Australia.
Green, E. E., Royal Botanic Gardens, Peradeniya, Ceylon.
Helms, Richard, 136 George Street, North Sydney, New South Wales.
Herrera, A. L., Calle de Betlemitas, No. 8, Mexico City, Mexico.
Horvath, Dr. G., Musée Nationale Hongroise, Budapest, Hungary.
Jablonowski, Josef, Entomological Station, Budapest, Hungary.
Kourdumuff, N., Opytnoe Pole, Poltava, Russia.
Kulagin, Nikolai M., Landwirtschaftliches Institut, Petrooskoje, Moskow, Russia.
Kuwana, S. I., Imperial Agricultural Experiment Station, Nishigahara, Tokio, Japan.
Lea, A. M., National Museum, Adelaide, South Australia.
Leonardi, Gustavo, R. Scuola di Agricoltura, Portici, Italy.
Lounsbury, Charles P., Department of Agriculture, Pretoria, Transvaal, South Africa.
Mally, C. W., Department of Agriculture, Cape Town, South Africa.
Marchal, Dr. Paul, 16 Rue Claude-Bernard, Paris, France.
Mokshetsky, Sigismond, Musée d'Histoire Naturelle, Simferopole, Crimea, Russia.
Mussen, Charles T., Hawkesbury Agricultural College, Richmond, New South Wales.
Nawa, Yashushi, Entomological Laboratory, Kyomachi, Gifu, Japan.
Newstead, Robert, University School of Tropical Medicine, Liverpool, England.
Porchinski, Prof. A., Ministère de l'Agriculture, Petrograd, Russia.
Porter, Carlos E., Casilla 2352, Santiago, Chili.
Pospielow, Dr. Walremar, Station Entomologique, Rue de Boulevard, No. 9, Kiew, Russia.
Reed, Charles S. Mendoza, Argentine Republic, South America.
Ritzema Bos, Dr. J., Agricultural College, Wageningen, Netherlands.
Rosenfeld, A. H., Estacion Experimental Agricola, Tucuman, Argentina.
Sajo, Prof. Karl, Gödöllö-Veresegyház, Hungary.
Schoyen, Prof. W. M., Zoölogical Museum, Christiania, Norway.
Severin, Prof. G., Curator Natural History Museum, Brussels, Belgium.
Shipley, Prof. Arthur E., Christ's College, Cambridge, England.

Silvestri, Dr. F., R. Scuola Superiore di Agricoltura, Portici, Italy.
Theobald, Frederick V., Wye Court, Wye, Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tryon, H., Queensland Museum, Brisbane, Queensland, Australia.
Urich, F. W., Victoria Institute, Port of Spain, Trinidad, West Indies.
Vermorel, V., Station Viticole, Villefranche, Rhone, France.

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Proceedings of the Twenty-Ninth Annual Meeting of the American Association of Economic Entomologists

The twenty-ninth annual meeting of the American Association of Economic Entomologists was held in the Teachers' College, Columbia University, New York City, December 28 to 30, 1916. The first session was held at 10 a. m., Thursday, December 28, when the annual reports of the officers of the Association were given. Owing to the illness of President Hewitt, his address was not delivered until Friday, December 29.

The meeting of the Section on Apiculture was held at 8 p. m., December 28, at the New York Museum of Natural History. The meeting of the Section on Horticultural Inspection was held at 2 p. m., December 29, at the Teachers' College at Columbia University and an evening session at the American Museum of Natural History.

The business proceedings of the Association are given as Part I of this report, and the addresses, papers, and discussions will be found in Part II. The proceedings of the sections will be prepared by the section secretaries and published as parts of this report.

The attendance was the largest of any meeting which has been held by the Association, and a very crowded and interesting program was given.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by First Vice-President George A. Dean at 10.15 a. m., Thursday, December 28, 1916. About 200 members and visitors attended this session. The following members were present.

Ackerman, A. J., Washington, D. C.
Ainslie, George G., Knoxville, Tenn.
Allen, H. W., Melrose Highlands, Mass.
Atwood, George G., Albany, N. Y.
Back, E. A., Washington, D. C.
Backus, H. E., North East, Pa.
Bailey, I. L., Northboro, Mass.
Ball, E. D., Madison, Wis.
Becker, G. G., Fayetteville, Ark.
Bentley, G. M., Knoxville, Tenn.
Beutenmuller, Wm., Bronx, N. Y.
Beyer, A. H., Columbia, S. C.
Bilsing, S. W., College Station, Texas.
Blackman, M. W., Syracuse, N. Y.
Bradley, J.W., Melrose Highlands, Mass.
Britton, W. E., New Haven, Conn.
Burgess, A. F., Melrose Highlands, Mass.
Clapp, S. C., Raleigh, N. C.
Cockerell, T. D. A., Boulder, Colo.
Collins, C. W., Melrose Highlands, Mass.
Cook, Mel. T., New Brunswick, N. J.
Cooley, R. A., Bozeman, Mont.
Cory, E. N., College Park, Md.
Crampton, G. C., Amherst, Mass.
Crawford, J. C., Washington, D. C.
Crosby, C. R., Ithaca, N. Y.
Crossman, S. S., Melrose Highlands, Mass.
Culver, J. J., Melrose Highlands, Mass.
Davis, I. W., New Haven, Conn.
Davis, J. J., Lafayette, Ind.
Dean, George A., Manhattan, Kan.
Dickerson, E. L., Nutley, N. J.
Dohanian, S. M., Melrose Highlands, Mass.
Eddy, M. W., State College, Pa.
Engle, E. B., Harrisburg, Pa.
Felt, E. P., Albany, N. Y.
Fenton, F. A., W. Lafayette, Ind.
Fernald, H. T., Amherst, Mass.
Fink, D. E., Norfolk, Va.
Fiske, R. J., Washington, D. C.
Fulton, B. B., Geneva, N. Y.
Garman, Philip, College Park, Md.
Gates, B. N., Amherst, Mass.
Gates, F. H., Tempe, Ariz.
Gibson, E. H., Alexandria, Va.
Glasgow, Hugh, Geneva, N. Y.
Gossard, H. A., Wooster, Ohio.
Gram, Ernst, Ithaca, N. Y.
Hadley, Charles H., Jr., State College, Pa.
Harned, R. W., Agricultural College, Miss.
Hawley, I. M., Indianapolis, Ind.
Headlee, T. J., New Brunswick, N. J.
Hertzog, P. M., Hightstown, N. J.
Herrick, Glenn W., Ithaca, N. Y.
Hewitt, C. Gordon, Ottawa, Canada.
Hinds, W. E., Auburn, Ala.
Hine, J. S., Columbus, Ohio.
Hood, C. E., Melrose Highlands, Mass.
Hopkins, A. D., Washington, D. C.
Houser, J. S., Wooster, Ohio.
Howard, C. W., St. Paul, Minn.
Howard, L. O., Washington, D. C.
Howard, N. F., Madison, Wis.
Hungerford, H. B., Ithaca, N. Y.
Hyslop, J. A., Hagerstown, Md.
Jennings, A. H., Washington, D. C.
Jones, D. W., Melrose Highlands, Mass.
King, J. L., Cleveland, Ohio.
Kisliuk, Max, Jr., Washington, D. C.
Kelly, E. O. G., Wellington, Kan.
Kotinsky, J., Washington, D. C.
Lamson, G. H., Jr., Storrs, Conn.
Larrimer, W. H., Charleston, Mo.
Lathrop, F. H., Columbus, Ohio.
Leiby, R. W., Raleigh, N. C.
Leonard, M. D., Ithaca, N. Y.
Lowry, Q. S., New Haven, Conn.
Manter, J. A., Storrs, Conn.
Marcovitch, Simon, St. Paul, Minn.
Marlatt, C. L., Washington, D. C.
Martin, J. F., Amherst, Mass.
Maxon, Asa C., Longmont, Colo.
McColloch, J. W., Manhattan, Kan.
McDonough, F. L., Clarksville, Tenn.
McLaine, L. S., Ottawa, Canada.
Merrill, G. B., Gainesville, Fla.
Merrill, J. H., Manhattan, Kan.
Metcalf, Z. P., W. Raleigh, N. C.
Minott, C. W., Hudson, Mass.
Morrison, Harold, Washington, D. C.
Morse, A. P., Wellesley, Mass.
O'Kane, W. C., Durham, N. H.
Osborn, Herbert, Columbus, Ohio.
Osgood, W. A., Durham, N. H.
Parrott, P. J., Geneva, N. Y.
Patch, Edith M., Orono, Me.
Peterson, Alvah, New Brunswick, N. J.
Phillips, E. F., Washington, D. C.
Phillips, Saul, Beverly, Mass.
Phillips, W. J., Charlottesville, Va.

Plank, H. K., Washington, D. C.
Quaintance, A. L., Washington, D. C.
Rane, F. W., Boston, Mass.
Reeves, George I., Salt Lake City, Utah.
Regan, W. S., Amherst, Mass.
Richardson, C. H., New York City.
Riley, W. A., Ithaca, N. Y.
Rockwood, L. P., Forest Grove, Ore.
Rogers, D. M., Boston, Mass.
Sanders, J. G., Harrisburg, Pa.
Sanford, H. L., Washington, D. C.
Sasscer, E. R., Washington, D. C.
Satterthwait, A. F., Lafayette, Ind.
Scammell, H. B., Washington, D. C.
Schaffner, J. V., Jr., Dover, Mass.
Seigler, E. H., Washington, D. C.
Shaw, N. E., Columbus, Ohio.
Shelford, V. E., Urbana, Ill.
Sherman, Franklin, Jr., Raleigh, N. C.
Simanton, F. L., Washington, D. C.
Skinner, Henry, Philadelphia, Pa.
Smith, G. A., Boston, Mass.
Smith, H. E., W. Springfield, Mass.
Smulyan, M. T., Blacksburg, Va.
Stockwell, C. W., Melrose Highlands, Mass.
Tower, D. G., Washington, D. C.
Turner, W. F., Vienna, Va.
Viereck, H. L., Washington, D. C.
Wade, Joe S., Wellington, Kan.
Walden, B. H., New Haven, Conn.
Washburn, F. L., St. Anthony Park, Minn.
Webber, R. T., Melrose Highlands, Mass.
Webster, R. L., Ames, Iowa.
Weiss, H. B., New Brunswick, N. J.
Wheeler, W. M., Forest Hills, Mass.
Wolcott, G. N., Champaign, Ill.
Woods, W. C., Orono, Me.
Wooldridge, Reginald, Melrose Highlands, Mass.
Worsham, E. L., Atlanta, Ga.
Worthley, L. H., Melrose Highlands, Mass.
Zappe, Max P., New Haven, Conn.

Vice-President George A. Dean: The meeting will please come to order. I am sorry to announce that Dr. Hewitt, President of the Association, is ill, but we hope he will be able to be present at a later session. The first business on the program is the report of the Secretary.

REPORT OF THE SECRETARY

The total membership of the Association at the time of the last annual meeting was 454, divided as follows: active 135, associate 267, and foreign 52. At that meeting one active member resigned, one was transferred to associate membership; five associate members resigned and seven were transferred to active membership; and 31 associate members were elected.

During the year, three active members have died and three active and five associate members have been dropped from the rolls. The deaths have been announced of two foreign members, Andrew Rutherford and Prof. Sven Lampa. The membership at present is 466, consisting of active 134, associate 282, and foreign 50, a net gain for the year of 12.

During the last meeting, held at Columbus, members of the Association were greatly shocked to learn of the severe illness of Prof. F. M. Webster, who had been present at the early sessions. He was taken to the hospital at Columbus, Ohio, and died January 3, 1916. Professor Webster was one of the original members of the Association and was well known and highly respected by all entomologists. On March 23, 1916, Mr. Theodore Pergande, one of the pioneer members of the Bureau of Entomology, died at Washington, D. C., and on November 18, 1916, Mr. Otto Heidemann of the same Bureau died after a brief illness. These three men were among the oldest members of the Association. Their loss has been severely felt by the Bureau of Entomology and indirectly by the entomologists of this country.

The Pacific Slope Branch which came into existence through the action taken at the last annual meeting held its annual meeting August 9–10, 1916, at San Diego, California, in connection with the meetings of the Pacific Coast Branch of the American Association for the Advancement of Science. The report of the sessions was published in the October number of the Journal and speaks for itself as to the success of the branch and as to the wisdom of its establishment. Mr. E. O. Essig, the secretary, has been very successful in handling the new branch and most pleasant relations exist between it and this Association.

The finances of the Association are in such a condition that the publication of the Index of American Economic Entomology can be undertaken if a reasonable number of advance subscriptions can be secured.

The Journal of Economic Entomology

The Journal has had a satisfactory year although the financial balance is somewhat less than last year. The complete proceedings of the Columbus meeting were published in the February issue, but it was impossible to mail this number until March 4. This number contained 252 pages in addition to the list of officers, meetings and members which is published each year.

In spite of this fact, the other numbers during the year were not materially reduced in size; 580 pages were published in 1916 against 566 for the previous year. The number of illustrations appearing in the Journal is increasing rapidly each year, which means additional cost both for their preparation and printing. Members are urged to submit only such illustrations as are vital to the proper understanding of the papers which they wish published. The Journal management will sell to authors at cost the cuts prepared for illustrating their papers and it is hoped that many of these can be disposed of in this way, as it will supply more funds for improving the publication.

The cost of issuing the Journal has increased during the past year. A contract has been signed for 1917 at a further advance. The price of paper and nearly everything that has to do with the publication has increased in price, and the expense next year will be approximately one-third greater than heretofore. The advertising in the Journal has decreased slightly as the manager has not felt warranted in pushing an aggressive campaign to sell space. Most of our old advertisers have remained without being persistently solicited, which speaks well for the publication as an advertising medium.

The report last year showed that the net increase in the subscription list was 44, and although many foreign subscriptions were cancelled there was a net gain of three in that class of subscribers. As anticipated the record of the past year has been less favorable and the future does not look encouraging. Total subscriptions for 1916 show 11 less than the previous year. There was an increase in the United States but a loss of 21 foreign subscribers was responsible for the unfavorable showing. In all probability, we will have less foreign business during the coming year. This means one of three things: an increase in price of the publication, which is now selling much lower than others of the same grade and size; the publication of less matter; or more interest among the members in securing additional subscribers. It should be an easy matter to solve the problem in the latter way. During the past year, several members have done good work in this respect. A little more energy in securing one more subscription to the Journal will solve the problem.

ASSOCIATION STATEMENT

Balance in Treasury, December 23, 1915		$621.31
By amount received for dues, 1916		457.00
By amount received from interest on deposits		5.86
To stenographic report 1915 meeting	$58.00	
Buttons 1915 meeting	14.66	
Stamps and stamped envelopes	29.42	
Printing programs, blanks, etc	78.25	
Telegraph and express	2.73	
Miscellaneous supplies	8.13	
Pacific Slope Branch expenses	15.23	
Official seal	12.00	
Clerical work, Secretary's office	38.00	
One-half salary of Secretary	50.00	
	$306.42	
Balance, December 20, 1916	777.75	
	$1,084.17	$1,084.17

Balance deposited as follows:

Melrose Savings Bank	$151.32
Malden National Bank	626.43

JOURNAL STATEMENT

Balance in Treasury, December 23, 1915		$755.02
By amount received for subscriptions, advertising, etc., 1916		2,281.07
To stamps and stamped envelopes	$24.74	
Printing	1,784.58	
Halftones, etc	273.94	
Miscellaneous supplies	20.86	
Refunds on subscriptions	2.60	
Returned checks	7.50	
Clerical work, Editor's office	70.00	
Clerical work, Secretary's office	55.00	
Salary, Editor	100.00	
One-half salary of Secretary	50.00	
	$2,389.22	
Balance, December 21, 1916	646.87	
	$3,036.09	$3,036.09

Deposited in Malden National Bank $646.87

Respectfully submitted,

A. F. BURGESS, *Secretary.*

On motion the report was accepted, and the financial part referred to the auditing committee.

VICE-PRESIDENT GEORGE A. DEAN: We will now hear the report of the executive committee.

REPORT OF THE EXECUTIVE COMMITTEE

The Executive Committee has pleasure in announcing that the question of a seal has been settled in accordance with the wishes of the Association and the instructions received at the last meeting. The committee was empowered to select either a plain seal or one bearing a profile of Harris and to have the seal prepared for official use. Under the direction of the President a design was made which included a profile of Harris, and the seal which has now been cut and completed is submitted for inspection. It is hoped that the result will meet with the approval of the members of the Association.

The President and Trustees of the Rutgers College of New Brunswick, N. J., invited the Association to send a delegate to the celebration of the 150th anniversary of the founding of the college which was held at New Brunswick, N. J., on October 13 to 15. Accordingly the President appointed Mr. P. J. Parrott of Geneva, N. Y., to represent the Association on this occasion. Mr. Parrott attended the celebration and has submitted an interesting account of the Proceedings; his report is included in the records of the Association.

C. Gordon Hewitt,
E. D. Ball,
W. J. Schoene,
T. J. Headlee,
A. F. Burgess,
Executive Committee.

By vote of the Association the report was adopted.

Vice-President George A. Dean: The report of the Employment Bureau is now in order.

ANNUAL REPORT OF ENTOMOLOGISTS' EMPLOYMENT BUREAU

December 26, 1916.

The Entomologists' Employment Bureau, organized five years ago, seeks to interest and help in the most impartial and impersonal manner possible, both employers and employees in the field of entomology. Its policy, under the present administration, has been, therefore, simply to bring together candidates seeking positions in various phases of entomological work and those employers who are responsible for the recommendations or appointments to such positions. When information concerning a possible position comes to the attention of the Bureau, it has been the practice to furnish to the employer a list of several names of such men as appear from their enrollment blanks to be best fitted for the position in question and possibly available for the appointment. An abstract of the principal points given on the enrollment blank with the names of parties to whom the candidate refers for additional information is furnished the employer for each name. (Copies of the forms used may be obtained on application.) It is expected that the employer should then select and communicate with such candidates as he desires to investigate further. Notice is also sent to each candidate whose name has been thus used, giving him notice of the reference so that he can, if he so desires, get into direct communication with the employer and learn full details regarding the position, and present complete and up-to-date information regarding his own qualifications for appointment.

During the calendar year 1916, twenty-two new names have been enrolled in the Bureau. Two men have received the total of 10 references offered by the Bureau for the enrollment fee of $2, and one of these has re-enrolled. The total number on the roll at present is 63.

Information has come to the Bureau regarding twenty-one openings, and among these, nine men suggested by the Bureau have been definitely placed, with eight more from which we have not yet heard because of recent notifications. One hundred sixty-one (161) names have been suggested to these possible employers for their further consideration and selection of such candidates as seem to be best fitted for the particular work desired. Nearly five hundred (500) letters have been sent out during the year.

During the five years that the Bureau has existed, it appears that a total of ninety-five (95) men have enrolled and at least twenty-five appointments have resulted through the services of the Bureau. This number is doubtless considerably less than the actual number of appointments, since it frequently happens that no direct information regarding the appointment is given to the Bureau.

An effort has been made this year to secure a general expression of opinion from employers and employees as to the value of the Bureau services to them, and also to bring out frankly whatever criticism might be made regarding the work of the Bureau and as a guide in future policy. Thirty-four (34) men have responded with their opinions regarding the Bureau. Of the employers, nine have found the Bureau of service to them; seven have had no occasion to use the Bureau; one expressed the opinion that there is "no field for the Bureau," although he had had no occasion to try it; no employer has expressed condemnation of either the policy or services offered by the Bureau.

Among the candidates for appointments, fourteen (14) have expressed appreciation of the helpful services rendered them, in some cases even where a change of position has not occurred. Three have expressed the feeling that the information furnished them by the Bureau has been too meager to be satisfactory. (It should be noted here that the information upon which the Bureau works is always meager, and this is one reason why it has been expected that employer and employee should correspond directly for complete information. A revised form of notification cards would make this point entirely clear.) Three (3) men seem to feel that it is a fault in the Bureau because information regarding various positions has come to them through other sources, at the same time some of the same men admit that they have not informed the Bureau regarding such openings, even where they have not considered them seriously themselves. We would suggest in this connection that the Bureau may be of much greater service if it can receive hearty coöperation from all members of the Association of Economic Entomologists.

Financial statement of the Bureau is presented herewith:

	Dr.	
Cash on hand January 1, 1916	$48.70	
To 22 enrollment fees at $2	44.00	
Total receipts		$92.70
	Cr.	
April 11, 1916, to multigraphing letters (voucher 1)	$1.00	
April 30, 1916, stenographic work (voucher 2)	10.00	
September 30, 1916, to stenographic work (voucher 7)	5.00	
November 24, 1916, to multigraphing letter (voucher 3)	1.25	
December 26, 1916, to stenographic work (voucher 4)	7.50	
December 26, 1916, to 500 envelopes (voucher 5)	2.40	
December 26, 1916, to stamps (voucher 6)	10.00	
Total		37.15
Balance cash on hand, Bank of Auburn, Ala., December 26, 1916		$55.55

W. E. Hinds, *In Charge.*

New York, N. Y., December 28, 1916.

We have examined this statement and have found it to be correct.

W. E. Britton,
R. A. Cooley,
Auditors.

By vote of the Association the report was adopted and the financial report referred to the auditing committee.

Vice-President George A. Dean: We will now hear the report of the committee on nomenclature, Mr. Herbert Osborn.

The committee on nomenclature had no formal report to offer at this meeting.

Vice-President George A. Dean: Next in order is the report of the committee on entomological investigations.

Mr. W. E. Hinds: Last year no report of the committee on entomological investigations was published. Owing to a misunderstanding I did not know that it was necessary for me to prepare the report this year, hence the inquiries in regard to obtaining the information was sent out rather late in the season. As a result, replies have been received from only a part of the members to whom letters were written. As soon as full replies are received the matter can be turned over to the Journal for printing, if it is the wish of the Association that it be handled in this way.

Mr. E. P. Felt: I do not wish to be considered as in any way criticising the committee, but I would like to raise the question at this time as to the actual value which the members receive from the publication of this report, and whether it is the intention to publish the projects of the United States Bureau of Entomology. In the past, they have been issued as a government publication, and it would not seem desirable to duplicate them in the Journal.

Mr. W. E. Hinds: I would be very glad to have an expression of opinion from the members as to the value of the reports of the committee on entomological investigations. Under the present arrangement, these must be rather lengthy if they are to be at all complete. It is not the intention, however, to publish the projects of the Bureau of Entomology.

Mr. W. C. O'Kane: A few years ago there was some discussion as to the advisability of publishing this report once in two or three years instead of annually. I believe myself that it should be published once in a while. If some of the remarks under the projects were cut out, I think it would make the report somewhat shorter and perhaps just as valuable.

Mr. T. J. Headlee: It seems to me these reports are valuable, but

they should be available before the meeting in order that a member may have an opportunity to consult with other members working on the same lines, at the time of the annual meeting. If mimeograph copies of the report were available at the meeting, I think it would be very helpful as it would give an opportunity for the members to talk over these matters.

A general discussion followed as to the best form for presenting the report, and, on motion, the matter was referred back to the committee with a request that the suggestions be considered and recommendations reported at the last session of the meeting.

Vice-President George A. Dean: We will now have the report of the committee on index of economic entomology.

REPORT OF THE COMMITTEE ON THE PUBLICATION OF THE INDEX OF AMERICAN ECONOMIC ENTOMOLOGY

Through the coöperation of Dr. L. O. Howard, chief of the U. S. Bureau of Entomology, and the devoted labor of Dr. Nathan Banks, the completed manuscript of the Index of American Economic Entomology is in the hands of the chairman of the committee. We regret to state that it has not been possible to secure the publication of this extremely valuable compilation by the U. S. Bureau of Entomology, though a very special effort was made on behalf of the project.

Previous action authorized the committee and the Secretary of the Association, who is also a member of the committee, to proceed with the publication of this work in the event of its being impossible to find any other satisfactory publishing agency. The latter has proved to be the case. The freedom of the committee was limited, however, by the adoption of a motion at the Atlanta meeting providing for the fixing of the maximum price of copies by the Association. The manuscript has been held since last September and the committee has limited itself to obtaining figures and considering details.

The printer's charges for an edition of 1,000 cloth bound copies in 8-point type would approximate very closely to $1,300 and in addition there would be some expense for author's corrections, the proofreading of the 350 pages in the editor's office, postage, etc. These latter are relatively small items. We prefer not to count on selling more than 200 copies at the outset though the probabilities are good that a much larger number can be sold within a five-year period.

The committee recommends that the editorial board of the Journal of Economic Entomology be authorized to proceed with the publication of the index and further, that the price of the index be fixed by the Editorial Board.

Furthermore, we recommend that the committee on the index be continued and specially charged with providing for the indexing of subsequent literature with a view to its publication later.

Respectfully submitted,

E. P. Felt,
W. C. O'Kane,
W. E. Britton,
A. F. Burgess,
W. E. Hinds,
Committee.

Mr. E. P. Felt: I would call attention to the fact that two different propositions are embodied in this report. The first—to give the editorial board of the Journal authority to publish the index and to fix the price; second—to continue the committee in order to have indexing of current publications kept up to date, so that another index can be published as soon as it is deemed advisable. The committee believes that it will be possible to arrange with Dr. Howard, chief of the Bureau of Entomology, to have this indexing done in the Bureau, but it seems desirable that the committee be continued to make the necessary arrangements.

While it is not desired to make money on this index, it is very necessary that the returns from the sale of the publication be sufficient so as not to involve the Association too deeply from a financial standpoint. A plan has been suggested to offer the volume to members for a limited period at an advance price of $4 per copy, about one month being given the members to take advantage of this opportunity, after which time the price will be increased. If we sell 250 copies, we will be able to handle the publication without embarrassing the treasury.

Mr. G. W. Herrick: From the figures submitted in the report, I presume an edition of 1,000 copies would require an outlay of about $1,500. If all were sold, $4,000 would be realized. I am wondering what would be done with the surplus funds. Of course it is improbable that we could sell 1,000 copies immediately. If the price could be made lower, I think more copies would be sold at once.

Mr. E. P. Felt: I would like to set the price lower but do not feel that we ought to run the risk of involving the Association. We have figured conservatively on being able to sell 200 copies. Personally I am inclined to think we could sell as many at $4 as at $3.50. We cannot figure that every member will buy a copy, and there will probably be a large reserve stock left over from which the Association will not realize anything for a number of years.

A Member: Would it not be a good idea for the committee to canvass the Association, addressing all the members as to whether they would subscribe at different prices and in this way get an idea as to the price that should be fixed.

Secretary A. F. Burgess: In handling this matter, I think the clerical work should be cut down to a minimum. We believe that this publication can be ready for distribution early in March. If a man is notified that he can receive a copy at a reduced rate before a given date, he can place his order enclosing payment, and the whole matter is settled in a single transaction. I think this would work out very satisfactorily and will reduce the clerical labor to a minimum.

By vote of the Association the report of the committee was accepted and recommendations adopted.

Vice-President George A. Dean: Inasmuch as Dr. Hewitt will probably be here tomorrow, the chair will appoint only one committee, that on auditing. As there is considerable work for this committee to do, it seems desirable that the appointment be made at once. I will therefore designate Mr. W. E. Britton and Mr. R. A. Cooley to take charge of the auditing.

Is there anything that should come up under the head of miscellaneous business?

Secretary A. F. Burgess: At the last annual meeting a committee was appointed to consider the matter of arranging the time of meeting, and the program. Unfortunately this committee was not able to present a report at the last session. It was the sense of the meeting, however, that the Secretary arrange the program for this meeting after consultation with the secretary of the Entomological Society of America. Probably there is no one present who has looked over this program that does not realize that it is exceedingly crowded. This has been necessary in order to get all the papers included. If it is the wish of the Association to jam forty papers into two sessions, the Secretary can do it, but if we want more time, we must make arrangements to have it. I would like to see the matter considered by a committee at this meeting, so that the wishes of the Association may be complied with.

Mr. T. J. Headlee: Some of us are very anxious to be able to attend the sessions of this Association and those of the Entomological Society of America, and we hoped that there would be no conflicts. There have been, however, at this meeting, and I do not think it possible to escape them. If there are any, it is a question of the survival of the fittest. The point made by the Secretary that he can jam forty papers into two sessions is an indication that the number of papers is so large that the time we would naturally use for coöperation with other Associations is taken up. I am in sympathy with the idea of making an effort to arrange the programs in harmony, and I think a committee should be appointed to take the matter up and report at a later session.

Secretary A. F. Burgess: The program was arranged this year so that there would be no conflict in time between the meeting of the Entomological Society of America and this Association and its sections.

Mr. W. A. Riley: As long as this matter is bound to come up year after year, some settlement should be made, and I think a committee should consider the matter.

Mr. W. E. Britton: I believe a committee should be appointed, and that the secretaries of the various sections should be members of the committee.

Secretary A. F. Burgess: I would rather not be a member of the

committee, but think that the matter should be considered by a committee made up of members of the Association, so that a better arrangement can be made in the future.

Mr. E. P. Felt: I do not believe we ought to excuse our Secretary from being a member of the committee inasmuch as he is familiar with the details in making up a program.

Mr. J. G. Sanders: I am a member of the Entomological Society of America and have a feeling that one of the difficulties experienced with their sessions is that they place no limit on the length of the papers. I have listened to papers which occupied 35 to 45 minutes and could not help feeling that the information could have been greatly condensed and much time saved. I believe the matter should be considered at this meeting.

It was voted that a committee of three be appointed to consider the matter and report at the last session.

Secretary A. F. Burgess: I have a letter from Dr. Howard, secretary of the American Association for the Advancement of Science, stating that all members of our Association who are not members of that association can join before January 1, 1917, without payment of the entrance fee of $5.

Mr. J. J. Davis: Professor T. D. A. Cockerell brought up a matter at the meeting of the Entomological Society of America yesterday in regard to present conditions at the National Museum, and a committee was appointed to consider the matter of extending the entomological work in the National Museum. I believe all of our members are interested and I would therefore move that a committee of five be appointed to coöperate with the committee of the Entomological Society of America. It was voted that this committee be appointed.

Vice-President George A. Dean: Is there any further business?

Mr. R. A. Cooley: I would like to bring up a matter in connection with the relation of our sections to the Association, as I think there is some difference of opinion among our members concerning it. The question of arranging sections on different activities should also be considered, and I believe a committee should be appointed to consider the matter.

It was voted that a committee of three be appointed to report at the final session.

Vice-President George A. Dean: I will now call for the report of Mr. P. J. Parrott, who was our special representative at the 150th anniversary of Rutgers College.

REPORT OF DELEGATE TO THE ANNIVERSARY OF THE FOUNDING OF RUTGERS COLLEGE

The one hundred fiftieth anniversary of the founding of Rutgers College was celebrated at New Brunswick, New Jersey, October 13–15, 1916, inclusive. The opening session of Friday morning consisted of commemoration exercises, the chief feature of which was a most interesting historical address by Dr. W. H. S. Demarest, President of Rutgers College. The afternoon was largely devoted to the anniversary pageant, which was given at the college farm in the open air with a charming, picturesque natural setting. In this exercise scenes of note in the history of the college and city and symbolical representations of the various branches of learning were presented by citizens, members of the faculty, graduate and undergraduate students. While there was no claim of absolute historical accuracy, either in action or costume, the performance showed great merit and made a strong appeal to æsthetic imagination and appreciation. As perhaps some of the members of our Association may recall, photographs of several of the scenes were subsequently reproduced in a number of the leading magazines and illustrated journals. The principal events on Saturday morning were the formal reception of the delegates, conferring of honorary degrees and presentation of addresses on behalf of colleges and learned societies. The remainder of the day was given over to attractions of special interest to the students and alumni. Sunday morning was noteworthy for the anniversary sermon and service, commemorating the connection between Rutgers College and the Reformed Church in America. In the afternoon the celebration was appropriately concluded with vespers, which was a service of praise and thanksgiving for the long and useful life of the college.

Other features of the celebration that might be briefly mentioned were the large number of delegates, representing about one hundred twenty-six universities and colleges, nine theological seminaries and twenty-eight or more learned and patriotic societies; the number of splendid addresses by men distinguished for their achievements in the academic world; the most hospitable entertainment, and various social activities, as receptions, luncheons and banquets, which were of increasing interest and pleasure with the development of comradeship among the delegates. Finally, as a fitting close, for an economic entomologist, to the many satisfying experiences of so short a period, a most enjoyable afternoon was spent in an automobile ride, through the courtesy of Doctor and Mrs. Headlee, to the salt marsh area of Newark where opportunities were afforded to see first hand some aspects of the mosquito problem and the progress of mosquito control in New Jersey.

Time does not permit a more extended account and references to other interesting aspects of the celebration are therefore omitted. Such, in brief, were the principal events of the auspicious anniversary of Rutgers College, an institution notable for a long period of honorable and effective service, high ideals of scholarship, and the many gifted and devoted sons she has nurtured, who occupy positions of trust and leadership throughout the land. That the achievements of a century and a half are but the harbingers of more magnificent accomplishments in the years that are to come is, I am sure, the wish of the American Association of Economic Entomologists, which society it was my privilege and honor to represent.

PERCIVAL J. PARROTT,
Delegate.

MR. T. J. HEADLEE: I trust the Association will allow me to express the appreciation of Rutgers College for the courtesy of sending a representative. The college appreciates it very sincerely, indeed.

Vice-President George A. Dean: I will now appoint the following committees:

Committee to Consider Schedule of Meetings; W. C. O'Kane, A. F. Burgess and J. S. Houser.

Committee on Entomological Work at National Museum; J. J. Davis, E. P. Felt, R. L. Webster, Herbert Osborn and E. D. Ball.

Committee to Consider Relationship of Various Sections to the Association; R. A. Cooley, J. G. Sanders and E. F. Phillips.

On Friday morning, the following committees were appointed by President Hewitt:

Committee on Resolutions; George A. Dean, G. W. Herrick and F. L. Washburn.

Committee on Nominations; E. P. Felt, A. L. Quaintance and P. J. Parrott.

On Saturday morning in order to enable newly elected members of the Association to take advantage of the opportunity to become members of the American Association for the Advancement of Science at the reduced rate, the report of the committee on membership was presented.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The committee on membership respectfully submits the following report:

The committee recommends:

1. That the Secretary be instructed to notify members who are in arrears for dues that unless the same are paid promptly, their names will be dropped from the roll.

2. That the following named persons be elected to associate membership:

H. E. Backus, North East, Pa.
William J. Baerg, Ithaca, N. Y.
John Wendell Bailey, Agricultural College, Miss.
Arthur Challen Baker, Washington, D. C.
Parker T. Barnes, Harrisburg, Pa.
G. E. Bensel, Oxnard, Cal.
John W. Bradley, Melrose Highlands, Mass.
W. L. Chandler, Ithaca, N. Y.
Royal N. Chapman, St. Paul, Minn.
Leroy Childs, Hood River, Ore.
Frank R. Cole, Washington, D. C.
George A. Coleman, University of California.
Richard Thomas Cotton, Rio Piedras, P. R.
R. W. Doane, Stanford University, Cal.
Senekerin M. Dohanian, West Somerville, Mass.
Allen Bowie Duckett, Washington, D. C.
E. H. Dusham, State College, Pa.
Philip Garman, College Park, Md.
Louis G. Gentner, Madison, Wis.
Ernest Gram, Ithaca, N. Y.
Clyde Carney Hamilton, Ithaca, N. Y.
Dwight Isely, Washington, D. C.
Dettmar Wentworth Jones, Melrose, Mass.
Harry B. Kirk, Harrisburg, Pa.
J. L. E. Lauderdale, Baton Rouge, La.
A. L. Lovett, Corvallis, Ore.
Arthur C. Mason, Gainesville, Fla.
S. L. Mason, West Lafayette, Ind.
T. F. McGhee, Tallulah, La.
Charles W. Minott, Hudson, Mass.
B. W. Moreland, Tallulah, La.
Earl L. Morris, San José, Cal.
Harold Morrison, Washington, D. C.
George Franklin Moznette, Corvallis, Ore.

Carl F. W. Muesebeck, Melrose Highlands, Mass.
Harry L. Parker, Hagerstown, Md.
George W. Peake, St. Paul, Minn.
C. E. Pemberton, Honolulu, T. H.
Saul Phillips, Beverly, Mass.
Charles J. Pierson, College Park, Md.
Harold K. Plank, Washington, D. C.
Charles H. Popenoe, Washington, D. C.
Edwin Booth Powers, Urbana, Ill.
H. J. Reinhard, College Station, Texas.
Dean A. Ricker, Ames, Iowa.
John V. Schaffner, Jr., Dover, Mass.
Howard L. Seamans, Bozeman, Mont.
Albert F. Swain, San Diego, Cal.
William Burke Turner, Hagerstown, Md.
Ray T. Webber, Melrose Highlands, Mass.
William H. White, College Park, Md.
Percy Barnette Wiltberger, Orono, Maine.

3. That the following named persons be transferred from associate to active membership:

E. O. Essig, Berkeley, Cal.
B. B. Fulton, Geneva, N. Y.
J. W. McColloch, Manhattan, Kan.
J. H. Merrill, Manhattan, Kan.
F. B. Paddock, College Station, Tex.
J. R. Parker, Bozeman, Mont.
Morley Pettit, Guelph, Canada.
E. W. Scott, Vienna, Va.
H. S. Smith, Sacramento, Cal.
J. M. Swaine, Ottawa, Canada.
W. R. Walton, Washington, D. C.
V. L. Wildermuth, Tempe, Ariz.

4. That the resignation of Mr. G. H. Hollister be accepted.

5. That the membership committee for 1917 prepare a statement quoting that part of the constitution referring to membership, together with the records and the minutes of other action that the Association has taken from time to time, relating to qualifications for membership and, in addition, any further statement that may be necessary to interpret clearly the existing policy of the Association as to standards of membership, with the intent that this statement, after consideration by the Association, be printed on the back of the blank application for associate membership.

Respectfully submitted,

W. C. O'Kane,
J. G. Sanders,
J. J. Davis,
Committee.

President C. Gordon Hewitt: The report of the committee is open for discussion. In passing this report, you will, of course, adopt the recommendations made by the committee in regard to elections.

On motion the report was accepted and the recommendations adopted.

After the passing of this report, the question of membership was discussed, particularly the policy pursued by the membership committee in connection with promoting associate members to active membership. Mr. T. J. Headlee protested against the action of the committee in promoting too few associate members to active membership and offered a motion providing that a special committee be appointed by the chair to recommend for the consideration of the membership committee the men whom it believes ought to be included in the active list. The question was discussed by nearly all the active members present and by vote of the Association the motion was lost.

At the afternoon session, the following business was transacted.

President C. Gordon Hewitt: I will first call for the report of the auditing committee.

REPORT OF THE AUDITING COMMITTEE

New York, N. Y., December 28, 1916.

We, the undersigned, have duly examined the accounts of W. E. Hinds, in charge of the Entomologists' Employment Bureau, and of A. F. Burgess, Secretary of this Association, and Business Manager of the Journal of Economic Entomology. All three accounts were found to be correct.

W. E. Britton,
R. A. Cooley,
Auditors.

By vote of the Association the report was accepted.

President C. Gordon Hewitt: We will now hear the report of of the committee on resolutions.

REPORT OF THE COMMITTEE ON RESOLUTIONS

Your committee submits the following.

1. The Association desires to express its sincere appreciation to the New York Entomological Society and to the Brooklyn Entomological Society for the enjoyable luncheon at the American Museum of Natural History and to the New York Zoölogical Society for the cordial reception at the Aquarium, and to Columbia University and the American Museum of Natural History for their generous hospitality and for the admirable facilities provided by them for the meetings of the Association.

2. The Association also takes this opportunity of expressing its appreciation of the great value of the recently completed Index of Economic Entomology and desires to extend to Dr. L. O. Howard its hearty thanks for affording the facilities of the United States Bureau of Entomology and its sincere gratitude to Mr. Nathan Banks for his untiring efforts in compiling this valuable work.

Respectfully submitted,

George A. Dean,
Glen W. Herrick,
F. L. Washburn,
Committee.

On motion the report was adopted and the Secretary instructed to send a copy of the resolutions to the persons named in the report.

President C. Gordon Hewitt: We will now hear the report of the committee on entomological investigations.

ENTOMOLOGICAL INVESTIGATIONS

In accordance with the instruction given me by the Association at the Thursday morning session, I would make the following recommendations regarding the report of the committee on entomological investigations.

1. That the report for 1916 be not published in the Journal of Economic Entomology as has been the custom heretofore.

2. That the material now in hand, together with such additional matter as may be reported to this committee, be compiled in as brief form as may seem serviceable

by arranging it in index form or otherwise as future committees may find possible and that a report be then prepared in mimeographed form and a copy be mailed to each active and associate member of the Association in America by December first of each succeeding year.

3. That the necessary expense in mimeographing and mailing this report shall be borne from the treasury of the Association of Economic Entomologists.

Respectfully submitted,

W. E. Hinds,
Chairman for 1916.

By vote of the Association the report was accepted and recommendations adopted.

President C. Gordon Hewitt: We will next have the report of the committee on programs.

Mr. W. C. O'Kane: In the week of next year that corresponds to this week, Christmas will come on Tuesday. When the American Association for the Advancement of Science will schedule its meetings, we do not know. The committee is therefore unable to suggest a program for next year that will specify days of the week. Instead it is submitting for your consideration a plan covering any succeeding year, as follows:

REPORT OF THE COMMITTEE ON FUTURE PROGRAM

The committee appointed to consider the matter of program for future meetings beg leave to submit the following report:

Owing to the continued growth of this Association and its sections, and the increasing difficulty in adequately presenting the program, it is recommended that three consecutive days be devoted to the sessions of the American Association of Economic Entomologists, and that no session be scheduled for Saturday afternoon.

Respectfully submitted,

W. C. O'Kane,
A. F. Burgess,
J. S. Houser,
Committee.

Mr. W. C. O'Kane: By three consecutive days is meant three consecutive periods of twenty-four hours, which might begin at noon on one day and end at noon of the second day following; or might begin in the morning and end in the evening of the second day following. This is intended to include the meetings of the sections.

Mr. T. J. Headlee: I take it that the report means that we are to disregard the meetings of the Entomological Society of America.

Mr. W. C. O'Kane: Perhaps I ought not to say more than is in the committee's report, but we have looked at the matter in this way. A week has six working days. We can begin our sessions on Thursday morning and end them before Saturday afternoon. There are present in this hall twelve or thirteen members of this Association to transact

the business. The committee believes that we should not attempt to hold a session on Saturday afternoon. Experience here and at previous meetings indicates that we need three days, or half of the total week for the meetings of our Association. The remainder of the week can be taken up by any other society, including the Entomological Society of America, if it desires.

President C. Gordon Hewitt: I think it is generally understood that it is the wish of the members that in arranging dates, the Secretary of our Association should notify the Secretary of the Entomological Society of America what dates we are selecting because it would be extremely unfortunate if we knowingly or without taking any trouble in the matter clashed with the times of their meetings when it could be possibly avoided, as there are many members of our Association who are almost equally interested in both meetings.

Secretary A. F. Burgess: I would like to say that the committee endeavored to confer with the Secretary of the Entomological Society of America before preparing this report, but found that he had left the city earlier in the day. We talked the matter over with one of the executive board of that society and it did not seem possible to arrange to accommodate every one. The Entomological Society of America has always been advised in advance in regard to the time for holding our meetings, and this course will be followed in future.

By vote of the Association the report was accepted and the recommendations adopted.

President C. Gordon Hewitt: I will now call for the report of the committee to consider the relation between this Association and its sections.

REPORT OF COMMITTEE ON RELATIONSHIP OF SECTIONS AND BRANCHES TO THE CENTAL ASSOCIATION

Your committee appointed to consider the relationship of sections and branches to the central organization respectfully submits the following:

We recommend that the official name of the Horticultural Inspectors be changed from American Association of Official Horticultural Inspectors to Section on Horticultural Inspection.

We recommend that the official name of the apiary inspectors be changed from Section on Apiary Inspection to Section on Apiculture, and that their activities be extended to include research in apiculture and education in apiculture.

As a guide in establishing any future sections and to record a definition of the activities of existing sections, we recommend that the purposes of sections be understood to be to discuss topics which are of such special nature as to be of only general interest to the majority of the members and of special interest to a limited number.

Respectfully submitted,

R. A. Cooley,
J. G. Sanders,
E. F. Phillips,
Committee.

Mr. R. A. Cooley: In connection with this report, I would like to say in regard to the change in the name of the Section of Apiary Inspection that this is desired by that section so as to enable it to consider research and educational matters in connection with apiculture as well as inspection work. There is, of course, no membership in the sections other than membership in the central Association and any members of the Association are permitted to attend meetings of the sections and take part in their deliberations.

I am quite certain that this statement will clear up some uncertainty among our membership. Papers presented at the sections are printed in the Journal, and it is of course understood that no action on policy can be taken by a section that would commit the Association without referring the matter to it for approval.

President C. Gordon Hewitt: The next business is the nomination of Journal officers by the advisory committee.

The advisory committee of the Journal of Economic Entomology makes the following nominations:

Editor, E. P. Felt.
Associate Editor, W. E. Britton.
Business Manager, A. F. Burgess.
(Signed) Advisory Committee.

By vote of the Association the recommendations were adopted.

President C. Gordon Hewitt: We will now listen to the report of the committee on nominations:

REPORT OF THE COMMITTEE ON NOMINATIONS

The committee on nominations begs leave to submit the following report:

For President, R. A. Cooley.
For First Vice-President, W. E. Hinds.
For Second Vice-President, A. W. Morrill.
For Third Vice-President, G. M. Bentley.
For Fourth Vice-President, B. N. Gates.
Committee on Nomenclature, G. W. Herrick.
Committee on Entomological Investigations, W. J. Schoene.
Committee on Membership, W. E. Britton.
Councillors to the American Association for the Advancement of Science, C. P. Gillette, H. A. Gossard.
Members of Advisory Committee, L. O. Howard, E. L. Worsham.

Respectfully submitted,

E. P. Felt,
A. L. Quaintance,
P. J. Parrott,
Committee.

By vote of the Association the secretary was instructed to cast one ballot for the election of the members named in the report. The ballot was cast and they were declared elected.

It was voted that the next annual meeting be held at the same time and place with that of the American Association for the Advancement of Science.

President C. Gordon Hewitt: We have now come to a final adjournment, but before adjourning, I would like to say what a pleasure it has been to me to preside over the greater part of the sessions. I only regret that I was prevented by illness from attending the first sessions. I should like to express my gratitude to Vice-President Dean for his kindness in taking my place at that time. I should also like to thank all the members of the various committees for the careful way in which they have carried out their duties, which are not always pleasant to perform, but I think every one will agree that these committees have done their work well.

There being no further business, the meeting adjourned at 3.55 p. m.

Respectfully submitted,

A. F. Burgess,
Secretary.

PART II. PAPERS AND DISCUSSIONS

Vice-President G. A. Dean: We will now take up the reading of papers. A letter has been received from Mr. Fiske stating that he would be unable to be present. I will therefore call for a paper by Prof. C. R. Crosby and Mortimer D. Leonard.

THE FARM BUREAU AS AN AGENCY FOR DEMONSTRATING THE CONTROL OF INJURIOUS INSECTS

By C. R. Crosby and M. D. Leonard, *Ithaca, N. Y.*

With the establishment of farm bureaus and with their subsequent growth, not only in numbers but also in efficiency and popularity, a new agency has been created for the dissemination of knowledge relating to the control of insect pests. This development is one that should be welcomed by those entomologists interested in making this knowledge available to the greatest possible number of persons engaged in agricultural pursuits.

The task confronting extension workers in entomology is not to "popularize" their subject, in the ordinary sense of the term, but to teach the farmers those entomological facts that have a direct bearing on their problems, and thereby induce them to incorporate such prac-

tices into their business as will prevent the greatest amount of loss from insect attacks.

Experience has shown that this result cannot be satisfactorily attained through the distribution of bulletins, circulars and leaflets, or by means of the popular lecture at farmers' meetings. The bulletin is laid aside and the lecture is soon forgotten. In order to induce farmers to modify their practices, it is necessary to convince them of the practicability and profitableness of such action. In most cases this cannot be done except through local demonstrations. With the small staff available for such work, even in the larger agricultural colleges, such demonstrations must be limited to relatively very few communities in the state. However, by coöperating with the farm bureau manager in each county, the extension worker from the college will be able to have demonstrations conducted in any community where conditions are such as to make them desirable. Not only does such an arrangement greatly increase the number of persons reached, but the college representative can learn much of local conditions and needs through the farm bureau association and its local committees.

In New York state, the Farm Bureau first of all consists of an organization of farmers joined together so as to act as partners with the College of Agriculture and the United States Department of Agriculture for the development of agriculture in their country. This association elects an executive committee which, jointly with the College of Agriculture, hires the farm bureau manager and decides along what lines work should be undertaken. In addition to this executive committee, each county has an advisory council composed of one to three association members from each community. It is through the members of this advisory council that the needs of each locality are brought to the attention of the executive committee. Under this method of organization the college extension worker can count on the coöperation not only of the farm bureau manager but also on that of the members of the association and its committees.

The farm bureau manager is usually a graduate of some agricultural college who, since his graduation, has had several years successful experience in conducting a farm business. He has had thorough training in the fundamental sciences of agriculture and his years of practical experience have tempered his enthusiasm and seasoned his judgment. He has a greater appreciation of the value of scientific work than the farmer, and he usually has a better knowledge than is possessed by the college extension worker of the difficulties and limitations experienced in attempting to incorporate the results of scientific investigation into a system of farm practice. He functions as a differential between the scientific wheel that tends to run too fast and the practical wheel that is inclined to go too slowly.

The farm bureau manager is in close touch with the needs of each community in his county and can give the college worker much valuable advice as to the subjects in which demonstrations are needed and as to the points requiring special emphasis. Through the local committees of his association, he is able to have the demonstrations located on the most suitable farms in each community and thus insure the work being conducted in a business-like manner. Where demonstrations are conducted as the result of a local demand and where the local organization has a voice in deciding on their location, greater interest is developed than where the whole program is conducted by outside agencies. Furthermore, under such circumstances, the demonstrations will be more likely to have a direct bearing on the needs of the community. There is also less danger of getting a poor coöperator; the local committee feels a considerable responsibility for the success of the demonstration and a larger number of farmers become familiar with all the details of the work.

In coöperative work of this kind, it is important that the demonstrations should be adapted to the conditions under which the crop is grown. For instance, while apples are grown more or less in every county of New York state, there are certain counties in which apple growing has become a specialized industry. To do effective demonstration work in the control of apple insects, this difference must be kept in mind. In those counties where most of the apples are grown in the small home orchard, the best results will probably be obtained by showing the advantages of following a rather simple spraying schedule. In some localities it might even be advisable to hold spraying demonstrations, but only where the growers are entirely unfamiliar with spraying machinery, spraying materials and methods of application. Such demonstrations would be entirely out of place in the localities where the growing of apples is a specialized industry. Here, demonstrations showing the relative value of different methods of application, different insecticides or different combinations of insecticides with fungicides would arouse greater interest and be of more permanent value to the community. The same condition holds in the case of potatoes. Where potatoes are not an important crop demonstrations of the benefits derived from spraying for the control of blight, the Colorado potato beetle and flea-beetle are all that is needed. In those localities, however, where potato raising is the main industry, demonstrations showing the comparative value of different forms of arsenical poisons (arsenate of lead, paste or powdered; Paris Green; or arsenite of soda) would be of greater benefit to the growers. In other words, the subjects for demonstration should be so chosen and so conducted that they actually help the grower to fight the insect enemies

of his crop in a practical way, that is, under the conditions actually existing on his farm.

It should also be remembered that, while it is important to so arrange demonstrations that they shall be of practical value and on a commercial scale, the main emphasis should be on the reasons for the success or failure of the work. By maintaining this attitude, successful demonstrations become of greater educational value and even failures may be made to teach important lessons. This is especially true of demonstrations of insect control where there are so many factors to be considered not under the control of the grower—such as weather, early or late seasons, severe or mild winters and the relative degree of development of plant and insect at critical times in the season.

In this connection, it might be well to point out that as far as insect work is concerned the farm bureau manager's activities fall under two heads—first, conducting formal demonstrations; and second, giving expert advice to those farmers engaged in growing special crops such as fruit or vegetables. In most cases the two methods can be combined to advantage. While many questions of insect control may properly serve as subjects for formal demonstrations, the local adviser in fruit growing regions will find that his services will be of much greater value to growers if he constantly keeps in very close touch with the insect situation and is able to give the growers expert advice as to the proper sprays and the proper time for applying them. Isolated formal demonstrations of methods of insect control cannot be of as great money value to the growers of a community as would results from continued and timely attention to their spraying problems throughout the season. The latter method has been tried out with highly satisfactory results in at least one county in New York where an assistant to the farm bureau manager was available to give his entire time and attention to this work throughout the season.

It is important to determine as definitely as possible what are the more serious insect problems in each locality. In this way it would be possible to concentrate attention on demonstrating the control of those insects which are most destructive and so prevent wasting energy on work against insects which are less injurious but which, on account of their novelty or conspicuousness, more often attract the attention of the grower. It is therefore desirable to determine as definitely as possible for each locality what are the most important insect problems before deciding upon a subject for demonstration. While this may be already known in a general way, there are many cases in which such information is lacking. In some instances it might be desirable to conduct surveys of insect problems in the growing of certain crops. For instance, an arrangement could be made with the farm bureau

manager for a survey of the insect problems in the greenhouses of his county, or a similar survey might be conducted among the vegetable growers.

In coöperating with the farm bureaus, it is important that there should be a definite understanding as to the nature and extent of the work. It is realized, however, that it is not always easy to plan demonstration work in insect control in advance of the season. The relative importance of even our most common pests varies greatly from year to year and it often happens that the greatest injury is done by an entirely unexpected insect. In spite of this fact, demonstration work should be planned as definitely as possible and adapted to the conditions under which the crop is grown. In conducting demonstrations, the aim should be to obtain as definite results as conditions will permit. In field tests of the methods of insect control, untreated plats should always be left for comparison. There are, however, some exceptions to this rule as, for instance, in the case of the pear psylla where it is necessary to treat the whole field to prevent reinfestation. Where the value of the crop is great, it is usually necessary to have the untreated area small in extent. This is especially true in orchards of large, old trees where few growers would care to lose the crop from more than two or three trees. In determining the results of field tests of methods of controlling insects, it is just as important to obtain definite data as in the case of fertilizer tests. General impressions are of little value. In some cases, as in the comparison of the effectiveness of different insecticides in controlling fruit insects, this entails a large amount of careful work—a tedious but necessary task, yet one well worth while. Results backed by definite figures have much more weight with those growers who are not able to see the tests personally than those presented as based on personal opinion or vague observation.

Since in many cases the control of insects must, in practice, be connected with the control of plant diseases, it is desirable that demonstrations be arranged whenever possible, in coöperation with the plant pathologist of the college.

In order to standardize spraying practice in a county, it is sometimes desirable to publish an extension bulletin on the control of insects for particular crops in that region. In such cases, the college representative would furnish the general discussion and illustrations, and the farm bureau manager would be able to contribute those finer points of control based on an intimate knowledge of local conditions that would make the publication of greater practical value in his county. Experience has shown that a bulletin prepared for a particular region or county is much more valuable to the growers than one written for the

whole state, because it is possible to make the directions more definite and to better adapt them to local conditions.

The farm bureau as organized in New York state has proved a most efficient agent for teaching methods of insect control in a practical way. Only a little over half of the agricultural counties of the state have farm bureaus, but when the whole state is organized it will be possible to reach any community quickly and effectively where there are insect problems needing a solution.

The farm bureaus offer facilities that greatly increase the efficiency of the extension work of the college. The responsibility of initiating and guiding this work along entomological lines rests upon the extension entomologists of the colleges. The problems to be solved are problems of applied entomology. They must be worked out by persons whose training and main interest are in entomology. They cannot be solved by the professional extension worker whose interest in entomology is secondary and whose knowledge of the subject is superficial.

Vice-President G. A. Dean: The next paper on the program will be read by Mr. B. H. Walden.

SIMPLE APPARATUS FOR INSECT PHOTOGRAPHY

By B. H. Walden, *Agric. Expt. Sta., New Haven, Conn.*

The subject of insect photography has been well covered by at least three papers read before this Association, containing much valuable information on the methods of technique which, to a certain extent, must be followed by all workers.

The present paper does not deal with this phase of the subject, but is rather a brief description of the simple photographic apparatus and methods for field and laboratory work used in the entomological department of the Connecticut Agricultural Experiment Station. Our laboratory photographs are made in one corner of the general workroom, where there is not room for a large and elaborate outfit, such as a camera and stand with an eight- or ten-foot bed. The work is done by the regular members of the department, often when the time could be used to advantage in the regular work. The apparatus then, should be as simple as possible, and easily and quickly adjusted. It usually follows that the larger or more elaborate the outfit, the more time it takes to manipulate it.

Laboratory Outfit.—The stand of the laboratory camera is the regular Folmer and Schwing laboratory stand on which the camera

can be used horizontally or vertically (Pl. 1, fig. 1). The majority of our insect photographs are made with the camera in the vertical position. A 5 x 7 view camera and a home-made camera, which will be described later, are used on this stand. The lens used for the most of our photographs is an anastigmat of $4\frac{1}{8}$-inch focus. The short focus lens has the following advantage over one of long focus for this work, (1) greater depth which increases as the focal length decreases and which, of course, is most marked in the micro-tessars; (2) the shorter bellows required and the shorter working distance in making photographs from natural size up to four or more diameters. The following figures illustrate this point. In photographing objects natural size with the $4\frac{1}{8}$-inch lens, the distance from the focusing screen to the center of the lens is $8\frac{1}{4}$ inches. The working distance is also $8\frac{1}{4}$ inches, making a distance of $16\frac{1}{2}$ inches from the ground glass to the object. Comparing an 11-inch focus lens, for example, the distance from the ground glass to the object is 44 inches. In photographing at two diameters, the total distance with the $4\frac{1}{8}$-inch lens is 18 9-16 inches against $49\frac{1}{2}$ inches with the 11-inch lens. In fact, the short focus lens is the key to the simple oufit which we use.

The specimens to be photographed are placed on a piece of fine ground glass with the ground surface up. The glass is supported on a frame which carries the background and can be raised or lowered. With the background at the proper distance below the ground glass, there is practically no trouble from shadows. The ground glass does not show reflections from the lens and metal parts of the camera, as is often the case with a plate glass support.

A 48 mm. micro-tessar lens is used for making enlarged photographs of small specimens, and with the 22-inch extension of the view camera, linear enlargements of ten times can be made.

The most of our exposures are made by daylight, white cardboard reflectors being used to illuminate the dark portions of the object. There is no doubt that the use of artificial light is advisable, especially when the natural light is poor, but it requires more or less skill in arranging the reflectors in order to obtain an even or pleasing illumination of the subject. The writer has used flash-light powder, without any special apparatus, in photographing insects when the natural light was not sufficient to make the exposure. About a teaspoonful of flash-light powder was placed on a sheet of tin slightly above and about two feet from the object. A large white cardboard reflector was arranged just back of the powder and similar reflectors were placed near the object, on the side opposite from the flash. The object was focused in the usual way and the lens stopped down to f. 16, a match on the end of a stick lighted, the cap removed from the lens, and the powder immediately touched off.

About 85 per cent of our laboratory photographs are either natural size or twice enlarged. A 5 x 7 box camera has been built to meet these requirements (Pl. 1, fig. 3). It consists of three sections built of one-half-inch wood and mounted on a baseboard which fastens to the sliding bed of the stand. The front section is firmly fastened to the baseboard and takes the regular lens board of the 5 x 7 view camera. The rear section slides up and down on the bed, and is fitted with a back from a regular camera. These two sections fasten together and with the $4\frac{1}{8}$-inch lens form a fixed focus camera for photographing natural size. A third section $4\frac{1}{8}$ inches long can be inserted between the other two sections, thus making the camera of the right length for photographing twice natural size (Pl. 1, fig. 4). The object can be centered by sliding the ground glass support back and forth in one direction and by moving the lens, which is mounted on a sliding lens board, in the other direction. This camera is absolutely rigid and is very simple and convenient to operate. The 48 mm. lens can be used to give the desired magnifications by means of extensions fitted in place of the regular lens board.

Field Outfits.—The department has three outfits for field work, a 5 x 7 camera with a triple entension, a 4 x 5 long bellows camera, and a $3\frac{1}{4}$ x $4\frac{1}{4}$ roll film camera. These cameras are all fitted with anastigmat lenses and good shutters. In addition to these, three members of the department have small high grade $2\frac{1}{4}$ x $3\frac{1}{4}$ cameras, which are very useful in field work. In fact, with the outfits mentioned above, their usefulness apparently increases as their size decreases. The small cameras are readily carried in the pocket, and are simple and inexpensive to operate. The high grade lenses, being of short focus, give sharp, clean negatives of good depth, which are capable of being enlarged to 8 x 10 or even to 11 x 14 inches. One of the most important features of these cameras is the fact that the negatives are just the right size for making lantern slides by contact.

In our 1915 report eight of the eleven illustrations showing field views were made from these $2\frac{1}{4}$ x $3\frac{1}{4}$ negatives.

Though the writer would not go so far as to recommend this size for all field work, he considers that the most useful size for a field outfit would be a compact plate camera, not larger than $3\frac{1}{4}$ x $4\frac{1}{4}$, with a long extension and fitted with a convertible anastigmat lens and a good shutter.

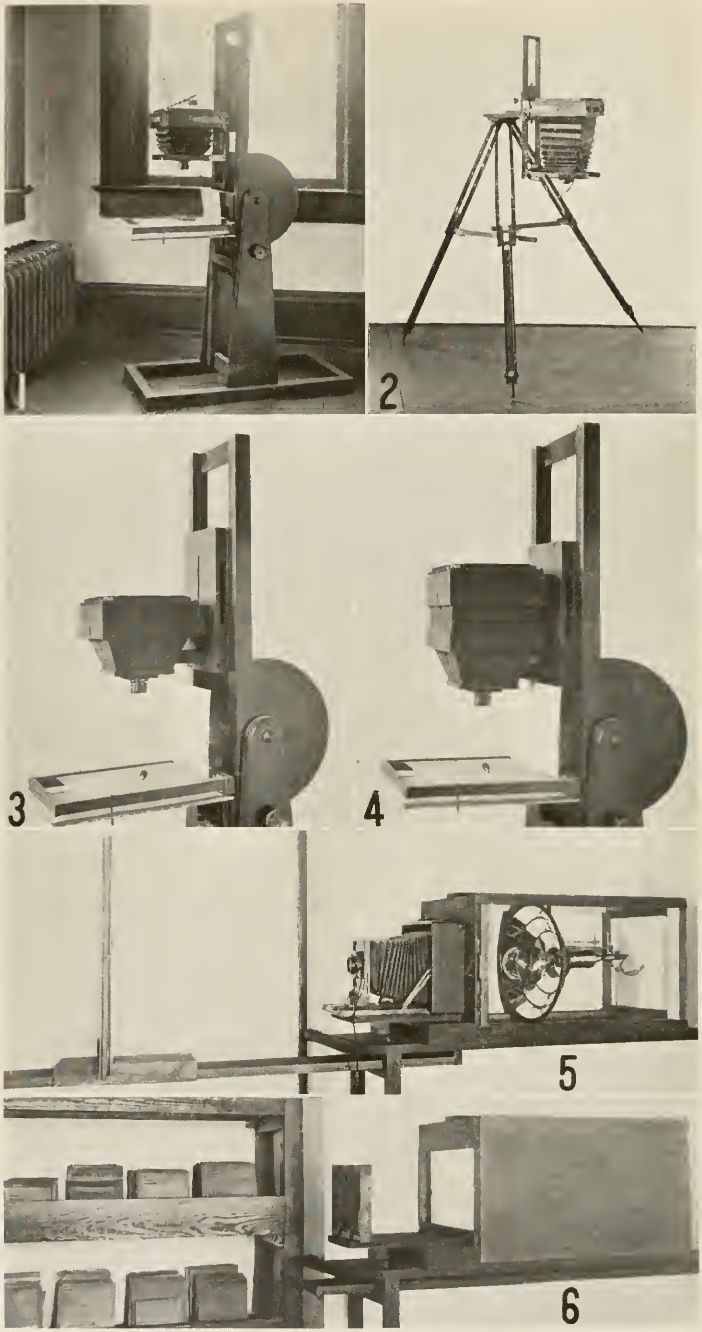
It is frequently necessary to make photographs in the field looking directly down on the ground. This can be accomplished by making a right-angled bracket of two pieces of board with a tripod socket in each; the horizontal part is fastened to the head of the tripod and should project far enough beyond the head to clear the tripod legs.

The camera is fastened to the vertical portion of the bracket and a tripod stay is advisable as the weight of the camera is at one side (Pl. 1, fig. 2). A view camera is much more convenient for this purpose than the average hand camera, as both the front and back can be racked up and down on the bed.

Enlarging Outfit.—With the use of the small camera and the increasing demand for enlargements for exhibition purposes, an enlarging outfit is a necessary part of the entomologist's photographic equipment. Our enlarger consists of a box in which is mounted a "Parallex" reflector; the front of the box is fitted with ground glass and a negative carrier to which our regular 5 x 7 camera is attached (Pl. 1, fig. 5.). The enlarged image is projected upon an easel which slides back and forth on a board. The "parallex" is a concave reflector with a series of mirrors each of which gives an individual reflection of the incandescent bulb, for which a socket is provided at the center of the reflector. Our reflector covers a 5 x 7 plate, has 64 mirrors, and the maximum illumination is obtained with a 300-watt nitrogen-filled bulb. The cost is much less than that of a pair of good condensers covering the same sized plate, and in some respects is more satisfactory. With sufficient distance to move the easel, and a good negative, the size of the enlargement is limited only by the size of the developing trays. With a long bellows on the camera the apparatus is equally convenient for making lantern slides by reduction. This outfit is in the dark room where the space is limited and is mounted on a shelf that was formerly used for printing. The enlarging easel is removable and the board support slides under the shelf out of the way (Pl. 1, fig. 6). The camera and negative carrier can readily be removed and we have an excellent light for printing, so that the two feet of shelf space which the box occupies is not missed.

Plate Developer and Paper.—Ortho- or isochromatic plates are used for practically all our work. Color screens are used when considered practicable. The plates are covered as much as possible during development, as there are no dark room lights which are absolutely safe with color value plates. Copies of charts or line drawings intended for lantern slides are usually photographed directly upon a lantern slide plate, developed in the lantern slide or contrast developer, and the slide printed by contact.

Pyro is one of the best developing agents for plates and is usually employed. Most workers have their favorite formula or developer so that it is not necessary to give one here. My experience is that many formulas call for too much sodium carbonate and too little water to give soft negatives of good gradation. The developer can often be modified to meet special requirements. The entomologist,



Photographic Apparatus

especially when engaged in medical entomology or similar lines, frequently wishes to photograph interiors where the light conditions are poor. The method used in making the illustration shown in figure 1 is useful when photographing directly against the light. The exposure given was sufficient to fully time the darkest portion of the object and was about ten times the normal exposure for the light conditions of the room. Development was started in a developer containing four or five drops of the carbonate solution instead of an ounce as ordinarily used. After the detail appeared a few drops of the carbonate solution were occasionally added, and the negative developed for about twenty minutes.

The prints intended for halftone illustrations are made on developing paper. In fact, at the present time practically all of the prints submitted to the local engraver for halftone work are on this class of paper. The loss of detail in our published illustrations has been due usually to unsuitable paper or to careless printing from the halftone plates rather than to poor halftones.

Lantern Slides.—In making lantern slides, a hydroquinone developer similar to the one recommended by the late Professor Slingerland has proven most useful. Also his potassium ferricyanide solution is excellent for local reduction. Weak or slightly underexposed slides can be considerably improved by redevelopment, the same as is used to produce sepia tones on bromide paper, providing, of course, the tone is suitable for the subject. It is often desirable to combine the views from two negatives on one slide. This can be done by alternately exposing each side of the plate, first covering one half of the plate with a card, making one exposure, and then covering the exposed side while the second exposure is being made. Care must be taken to have the exposures similar. An easier way to accomplish this is to make the first exposure on one plate and the second exposure on another plate, using the latter for the cover glass. If the reversed image of the second exposure is objectionable, the negative can be reversed in the camera before making the exposure.

A brief description of the method of indexing our negatives and prints

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Explanation of Plate 1

Fig. 1. Laboratory stand and view camera.

Fig. 2. Home-made bracket and tripod stay for photographing vertically.

Fig. 3. Home-made box camera for photographing natural size.

Fig. 4. The same with extension for photographing twice natural size.

Fig. 5. "Parallex" enlarger with side removed.

Fig. 6. Enlarger as used for printing.

may be of interest. The negatives when filed are numbered consecutively and catalogued in a book in the same sequence. After several negatives of a subject had been made, it was often necessary to examine a number of negatives to find the one desired. A card index is used to supplement the book catalogue. A print from each negative is mounted on a regular 5 x 8 index card. The subject and number of the negative is placed at the top and the cards are arranged alphabetically. The prints used are often some that are not suitable for halftones and are attached to the cards with binding strips or a non-curling gelatine mountant. Prints from two or more different negatives of the same subject are often mounted on the same card. This index has proven very convenient and saves much time in looking up negatives.

Thus with the simple apparatus and devices described, photographs up to ten diameters, prints, enlargements of any reasonable size and lantern slides can be quickly and conveniently made. This occupies less than seven square feet of space and could be duplicated for between $100 and $120.

Vice-President G. A. Dean: The paper is now open for discussion.

Mr. G. W. Herrick: I would like to ask if Mr. Walden has any trouble with shadows when he places his specimens on a horizontal shelf.

Mr. B. H. Walden: The specimens are placed on a sheet of ground glass. Many workers use plate glass, but we prefer the ground glass and if the background is placed a proper distance below, we have very little trouble with shadows.

Mr. W. C. O'Kane: Mr. Walden's statement with regard to a field camera with high grade lens is interesting. I should like to ask if he has had experience with supplemental lenses added to an ordinary lens thereby avoiding long focus bellows, because our experience with long focus has not been pleasant. I have not had any experience with supplementary lenses but should like to know about it.

Mr. B. H. Walden: I have never used a supplementary lens for this work, but have seen one used in connection with other work and the results were not entirely satisfactory.

Vice-President G. A. Dean: We will now listen to a paper by Dr. T. J. Headlee.

SOME FACTS RELATIVE TO THE INFLUENCE OF ATMOSPHERIC HUMIDITY ON INSECT METABOLISM

By Thomas J. Headlee, Ph. D., *New Brunswick, N. J.*

The effect of atmospheric moisture (water vapor) upon the speed of insect metabolism is seemingly extremely variable. It has been shown that moist air retards in some cases the development of the eggs of *Dendrolimus pini*[1] while in other cases it seems to hasten it. Moist air hastens the development of the larvæ (change from larva to pupa) of *Mayetiola destructor*[2] and dry air greatly retards it. Dry air retards the development of the pupa of *Lygellus epilachnæ*[3] and hastens that of *Pieris brassicæ*[4]. Moist air is injurious to the adults of *Dorcadion sturmii*[5] but highly favorable to plant lice. Dry air, even when warm, causes lethargy in *Phytodecta viminalis*[6] and several other species.[7] Neither dry nor moist air materially affects the speed of metabolism in *Toxoptera graminum* when feeding on young and succulent wheat.[8]

The writer undertook the study of the response of the various stages of the bean weevil (*Bruchus obtectus* Say) for the purpose of finding out to what extent the variations of speed of metabolism in response to atmospheric humidity held true in a single species entirely dependent upon metabolic water and for the purpose of deriving data that might lead to the underlying cause of the response.

Realizing the extent to which factors such as temperature and light would interfere with the results and having an idea that the presence of carbon dioxide and oxygen might influence the results, an effort was made to eliminate them as variables. All insects were kept at a practically constant temperature of 80° F.; all were kept in complete darkness; all were subjected to a passing stream of air, the minimum

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[1] Serebrjanikaw, A. W., Nachr. des Forst. Instit. zu St. Petersburg, VII., p. 29–102, 1901.

[2] Headlee, Thos. J., and Parker, J. B., Bull. No. 188, Kans. St. Agr. Expt. Station, p. 107–109, 1913.

[3] Giard, A., La methode experimentale dans l'Entomologie, Bull. Soc. France No. 4, p. 57–63, 1896.

[4] Urech, Friedr., Chemisch-Analytische Untersuchungen an lebenden Raupen Puppen und Schmetterlingen und ihren secreten, Zoölog. Anz. 1890, No. 335, p. 254–262, No. 336, p. 272–280, No. 337, p. 309–314, No. 338, p. 335–345.

[5] Bachmetjew, P., Experimentelle Entomologische Studien, Band 11, p. 574, 1907.

[6] Kolbe, H. S., Einfürung in der Kenntnis der Insekten, 1889–1893.

[7] Bachmetjew, P., l. c., p. 688.

[8] Headlee, Thos. J., Jour. Ec. Ent., Vol. VII, No. 6, p. 416, 1914

rate of which was one liter in eight minutes or less. Barometric pressure was the only variable against which no fairly complete measures were taken. In so far as possible the influence of this variable was annulled by running the experiments simultaneously.

The first phase of the investigation was concerned with the effect of atmospheric humidity on late larval and the pupal stages and included the responses of both the bean weevil and the Angoumois grain moth (*Sitotroga cerealella* Oliv.).

Table Showing the Effect of Atmospheric Moisture on Rate of Development of the Late Larval and Pupal Stages of the Angoumois Grain Moth and the Bean Weevil

Chamber	Temp.	Atmospheric moisture	Date of beginning	Emergence		No. of specimens
				No. of days in period	No. of days to maximum	
Angoumois grain moth						
Chamber No. 1	80° F.	100 %	1/17	17	9	26
Chamber No. 2	80° F.	72.6%	1/17	17	7	8
Chamber No. 3	80° F.	44.7%	1/16	16	11	8
Chamber No. 4	80° F.	21.8%	1/15	12	6	16
Bean Weevil						
Chamber No. 1	80° F.	100 %	1/16	22	5	32
Chamber No. 2	80° F.	71.5%	1/16	21	6	27
Chamber No. 3	80° F.	44.6%	1/15	14	4	39
Chamber No. 4	80° F.	21.5%	1/15	15	7	31

It is here unmistakably shown that the speed of metabolism in the pupa is increased, the period being shortened in case of the moth from 17 days in 100 per cent to 12 days in 21.8 per cent and in the case of the weevil from 22 days in 100 per cent to 14 days in 44.6 per cent.

The next phase considered was length of adult life which in all probability may be taken as a measure of the speed of adult metabolism.

In the moth the length of the period was shortened by a decrease in atmospheric humidity varying from 18 days at 100 per cent to 15 at 44.7 per cent and below. In the weevil, on the other hand, the period as a whole was apparently but little affected. When, however, period to maximum death is examined it becomes plain that the life of the adult weevil was prolonged by a decrease in humidity as shown by the increase of the period from 3 days in 100 per cent to 12 in 44.6 per cent and below.

Table Showing the Effect of Atmospheric Moisture upon the Length of Adult Life for the Angoumois Grain Moth and the Bean Weevil

Date of beginning	No. of days in period	No. of days to maximum
Angoumois grain moth		
1/21	18	8
1/21	16	7
1/22	15	8
1/21	15	6
Bean Weevil		
1/20	17	3
1/21	16	7
1/17	19	12
1/16	18	12

It seems that a decrease in atmospheric moisture increases the speed of metabolism in the moth and decreases it in the bean weevil.

The next phase investigated was the effect of humidity upon the length of the entire life cycle.

Table Showing the Influence of Atmospheric Moisture upon the Length of Life Cycle in the Bean Weevil

	Chamber	Temp.	Moist.	Date when majority of 1st brood	Date when majority of 2nd brood have emerged	No. of days involved	No. of specimens	
							At beg.	At end
First Test				is dead				
	No. 1	80° F.	100 %	2/5	2/25	20	25	150
	No. 2	80° F.	69.3%	2/4	2/27	23	25	129
	No. 3	80° F.	44.1%	2/2	2/29	27	25	11
	No. 4	80° F.	20.5%	1/31	Not at all		25	00
Second Test				has emerged				
	No. 1	80° F.	100 %	2/25	4/3	38	131	491
	No. 2	80° F.	59.4%	2/27	4/6	39	129	27
	No. 3	80° F.	39.9%	2/29	4/10	41	15	14
	No. 4	80° F.	23.6%					
Third Test				is dead				
	No. 1	80° F.	100 %	9/3	Fungi destroyed both beetles and beans		25	00
	No. 2	80° F.	62 %	9/3	10/4	31	25	101
	No. 3	80° F.	26 %	9/2	Nothing emerged		25	00
	No. 4	80° F.	1 %	9/1	Nothing emerged		25	00

It is apparent from the records of the first and second brood that the rate of metabolism is decreased by a reduction in atmospheric

moisture, the period ranging from 20 days in 100 per cent to 27 in 44.1 per cent in the first brood and from 38 in 100 per cent to 41 in 39.9 per cent in the second brood. It seems clear that a reduction of moisture to 26 per cent or below absolutely prevents reproduction. It seems also that in 100 per cent fungi may develop to such an extent that both weevil and beans are destroyed.

The great reduction in progeny which accompanied the reduction in atmospheric moisture led to an investigation of the cause. Thinking that the reduction might be the result of reduced fecundity a study of that phase was undertaken.

Table Showing the Effect of Different Degrees of Atmospheric Moisture on the Number of Eggs Laid

Chamber	Temp.	Moist.	No. of days in period	No. of beetles	No. of females	No. of eggs per female
No. 1	80° F.	100%	14	25	16	43
No. 2	80° F.	62%	13	24	9	27
No. 3	80° F.	26%	8	25	9	30
No. 4	80° F.	1%	8	25	12	29

While reduction in atmospheric moisture reduces the number of eggs produced by the average female, that reduction is certainly not sufficiently large to explain the observed reduction in progeny.

Accordingly attention was directed towards the egg stage. Eggs were subjected to two moistures 100 per cent and 23.6 per cent. They hatched in both but required an average of six days in the former and four in the latter. An examination seven days after the last egg hatched showed many of the beans in 100 per cent penetrated by the larvæ and a complete absence of penetrations among the beans under 23.6 per cent. This seems to show that the absolute prevention of progeny in 23.6 per cent is due to the destruction of the larvæ before they can penetrate the beans, and it seems not unlikely that the great reduction in progeny which accompanies reduced atmospheric humidity may be due to the same cause, although the effect upon the larvæ yet remains to be investigated.

It thus appears that the speed of metabolism in the pupæ of both the bean weevil and the Angoumois grain moth varies inversely with the atmospheric humidity; that in the adult of the former it varies with while in the adult of the latter it varies inversely as the humidity; that in the egg stage the speed of metabolism varies inversely with the humidity; that in the larvæ it varies with the humidity; that in the life cycle as a whole the speed varies with the humidity.

The bean weevil and the Angoumois grain moth offer many of the *variations* in response of speed of metabolism to atmospheric moisture

that were illustrated at the beginning of this paper and lend support to the theory which was partly set forth by Bachmetjew.[1] "Apparently there is a degree of atmospheric humidity, which being the most favorable to the maximum speed of insect metabolism should be designated as the optimum; that this optimum varies for each species, for each stage of each species, and for each stage of each individual."

When considering this question it must be remembered that we are dealing, in this instance, with species which are totally unable to imbibe and which must depend entirely upon metabolic water. According to Babcock[2] the sources of metabolic water are mainly three,—oxidations of food and tissues, breaking up molecular structure into new forms of a lower order, and changing the molecular structure of substances composing its nutrients and tissues without reducing their complexity. The first two produce CO_2 and all three produce metabolic water. It must also be remembered that when dealing with an insect or with insect stages which can imbibe the maintenance of the water optimum against the influence of evaporation is easy and that variations in atmospheric moisture may under such conditions prove ineffective as shown in the case of *Toxoptera graminum*.

Among insects or insect stages dependent upon metabolic water alone, this response to atmospheric moisture can best be accounted for on the supposition that for each stage of each insect there is a definite internal water optimum—an amount of body fluid which will permit necessary chemical and physical changes to take place with the greatest ease and speed. It would seem that atmospheric humidity can act upon the insect directly in two ways—by the removal of water, and by the prevention of the loss of body fluid.

Under the terms of this theory the direct effect of atmospheric moisture upon the specific stage of a specific insect depends upon the relation of the supply of body fluid to the optimum. If it be well above, dry air will remove the surplus and cause the metabolism to speed up as in the pupa or egg stage of the bean weevil, while moist air by preventing the rapid reduction of body fluid will prolong the stage. If the body fluid be just about the optimum, dry air will reduce it below that point and decrease the speed of metabolism while moist air will prevent the decrease of body fluid and shorten the time required to complete the stage of development as illustrated by the larvæ of the bean weevil.

Continued exposure to dry air will reduce the body fluid until the tissues become so poorly supplied that living processes can no longer

[1] Bachmetjew, P., l. c., p. 689.

[2] Babcock, S. M., Wisconsin Research Bull. No. 22, Wis. Agric. Expt. Sta., pp. 88–89.

continue and death follows. This is well shown in the destruction of the bean weevil larvæ, and the pupal stages of the Hessian fly[1] by drought.

Continued exposure to moist air does not seem to produce death directly but rather to encourage digestive troubles[2] and to supply the conditions for the destructive growth of parasitic fungi as was the case with the third test of the bean weevil.

Naturally, the inability of the bean weevil to reproduce in moisture of 26 per cent and below led to an examination of dry air as a means of sterilizing and preserving bean seeds from weevil injury.

The first set of experiments, which bore at all on this point, were laid out for an entirely different purpose, but the data from them bears on this matter sufficiently to justify their introduction. Five glass museum jars each with a capacity of one liter were selected and into the first was poured 250 cc. of concentrated sulphuric acid of specific gravity 1.83, into the second a mixture of 125 cc. of distilled water and 125 cc. of concentrated sulphuric acid, into the third a mixture of 83 cc. of acid and 167 cc. of water, into the fourth 250 cc. of distilled water and into the fifth nothing whatever. Into each of five wide-mouthed two-ounce bottles were introduced enough white beans to cover the bottom, and 25 healthy specimens of the bean weevil. The mouth of each bottle was covered with gauze and the bottle suspended from the inside of the glass cover which was then clamped on the jar on a rubber gasket.

In slightly more than one month after the experiment started the jars were opened and the beans examined. In the jar having 250 cc. of acid all weevils were dead and the beans free from injury. In the jar having 125 cc. of acid and 125 cc. of water the same condition was found. In the jar having 83 cc. of acid and 167 cc. of water living beetles of the second brood were found and many of the beans had been perforated. In the jar having 250 cc. of distilled water both weevils and beans were destroyed by fungi. In the jar having air only, a large brood of second brood beetles were found and most of the beans were perforated.

It thus appears that reproduction of the weevil in tightly closed jars can be prevented by the introduction of sufficient concentrated sulphuric acid to keep the atmospheric humidity low.

The second experiment relative to the utilization of a dry atmosphere to destroy bean weevil was planned for that specific purpose. Ten glass museum jars each of one liter capacity were chosen and a two-

[1] Headlee, Thos. J., and Parker, J. B., L. c., p. 108–109.

[2] Standfuss, M., Handbuch für Sammler der europäischen Gross-Schmetterlinge, 1891.

ounce bottle furnished with beans and weevils as described in the first experiment suspended from the inside of each lid. In jar No. 1 .01 cc. of concentrated sulphuric acid (sp. gr. 1.83) was placed, in jar No. 2, .03 cc., in jar No. 3 .05 cc., in jar No. 4 .1 cc., in jar No. 5 .25 cc., in jar No. 6 .5 cc., in jar No. 7 1 cc., in jar No. 8 5 cc., in jar No. 9 10 cc., and in jar No. 10 nothing whatever. The lids were set in place and clamped down on rubber gaskets.

The experiment was started August 30, 1916, and discontinued December 12, 1916.

TABLE SHOWING THE EFFECT OF A DRY ATMOSPHERE ON THE BEAN WEEVIL

Treatment	Total number of beans	Total number of holes	Number of holes per bean
.01 cc. of H_2SO_4 (sp. gr. 1.83)	36	163	4.5
.03 cc. of H_2SO_4 (sp. gr. 1.83)	26	43	1.6
.05 cc. of H_2SO_4 (sp. gr. 1.83)	20	158	7.9
.10 cc. of H_2SO_4 (sp. gr. 1.83)	23	230	10.
.25 cc. of H_2SO_4 (sp. gr. 1.83)	24	116	4.5
.5 cc. of H_2SO_4 (sp. gr. 1.83)	22	61	2.7
1 cc. of H_2SO_4 (sp. gr. 1.83)	26	54	2.0
5 cc. of H_2SO_4 (sp. gr. 1.83)	22	00	0.0
10 cc. of H_2SO_4 (sp. gr. 1.83)	134	00	6.1
Nothing	35	236	

Thus we see that in a sealed chamber about 5 cc. of concentrated sulphuric acid per 1,000 cc. of air prevents reproduction when a limited number of beans is used. The amount will have to be increased in proportion to the moisture which the bean can give off.

The next step was to determine whether the viability of the beans had been injured by the exposure to dry air, and a germination test was undertaken with the following results. The period of exposure was 92 days.

TABLE SHOWING THE EFFECT OF DRY AIR ON VIABILITY OF BEAN SEED

Treatment	Total No. of beans	No. which germinated	Pea cent which germinated
Control	35	32	91.4
5 cc. H_2SO_4 (sp. gr. 1.83)	22	19	86.3
10 cc. H_2SO_4 (sp. gr. 1.83)	34	27	79.4

It thus appears that prolonged exposure of 92 days results in injury. It should be remembered that the period required for sterilization does not exceed 30 days, and that in view of the small amount of harm of even the prolonged exposure, a period of the necessary length would not injure the viability in the least.

In this connection it is interesting to note that Chambers[1] relates a native method of protecting maize from weevils by mixing the grain with finely powdered wood ashes. He notes that a layer of wood ashes on the outside of the sack alone is effective. The editor[2] of the publication in which Chamber's article appears states that a layer of building lime on the floor of the storing place and between successive layers of bags gives satisfactory results. While one would normally attribute these results to the caustic effect of the ashes or lime, the fact that the substance appears to protect even when not in direct contact when taken with the well known hygroscopic qualities of ashes and lime leads one to suspect that here we have the practical application of the effect of low relative humidity.

Adjournment.

Afternoon Session, Thursday, December 28, 1916, 2 p. m.

Vice-President G. A. Dean: The Association will please come to order. The first paper on the program will be read by Mr. C. H. Hadley, Jr.

THE SEVENTEEN-YEAR LOCUST IN WESTERN NEW YORK

By C. H. Hadley, Jr., and R. Matheson

During the summer of the year 1916, the periodical cicada or "seventeen-year locust," *Tibicen septendecim*, appeared in varying numbers in several counties in western New York. This brood, brood VII of Marlatt's nomenclature (brood XIX of Riley's nomenclature), last appeared in New York in the year 1899, and was reported by Lowe[3] and Felt[4] as having occurred in Monroe, Livingston, Ontario, Yates, Cayuga, Madison and Onondaga Counties.

The following notes of the occurrence of these insects during the past summer, incomplete as they are, are presented as a matter of record.

Livingston County—On June 22, the insects were found in large numbers in Sonyea, on the grounds of the Craig Colony for Epileptics. One colony was in a grove of young oak trees covering ten or more

[1] Chambers, F., A Defence against Weevils, Rhodesia Agric. Jl., Salisbury, XIII, No. 3, June, 1916, pp. 397–398. Taken from Rev. of App. Ent., Vol. IV, ser. A., pt. 9, p. 391.

[2] l. c., p. 391.

[3] Lowe, V. H., Bulletin 212, N. Y. (Geneva) Agri. Exp. Sta., 1902.

[4] Felt, E. P., 15th Report, N. Y. State Ent., 1899.

acres, from which the insects had scattered into nearby woodlands. At places the emergence holes were very abundant, as many as forty or more having been counted in a square foot in various places. It was stated that the insects had first been observed early in the month. At this date, June 22, very few egg punctures could be found and only occasionally were females found in the act of ovipositing. Mating pairs were common.

The other colony was found a few miles away from that mentioned above, covering at least 100 acres of the woodland. Apparently the cicadas had been even more abundant in this place, as the exit holes were very much more numerous. A road had been run through these woods within a few years, and emergence holes were common in the bed and along the sides of this road. In this colony, which was examined on June 23, egg laying seemed to be more advanced, as many females were observed in the act of ovipositing, and almost all of the bushes and smaller branches of the trees showed numerous egg punctures.

It was stated that the locusts had also appeared near Geneseo, in Livingston County.

Mr. H. H. Knight informed the writers that he found this species in some numbers at Conesus Lake.

Ontario County—At Holcomb, the cicadas were exceedingly abundant on the farms of F. E. Burt and Henry Chapin, covering over 200 acres of orchards and woodland. The writers were told that this was the third successive appearance of the insects in part of the orchard to be observed by Mr. Chapin himself. The ground throughout the whole orchard was literally riddled by the emergence holes of the cicadas. Mr. Burt's orchards, just across the road, presented a similar appearance. It was stated that the insects appeared during the first week of June. At the time of the writers' first visit to this place, June 24, the insects had apparently just commenced egg laying, and were abundant on both old and young apple trees and in a young cherry orchard located between the old and young apple orchards. At the time of the writers' second visit, June 29, egg laying was in full sway. Comparatively little damage was done in the old apple orchard, but the young apple orchard, comprising about ten acres of Rome Beauty trees, set the previous year, was entirely destroyed. Many of the trees were dead on this date, and it is doubtful if a single tree survived the attack. The cherry orchard previously mentioned seemed to suffer little injury, as relatively few locusts were present, and scarcely any egg punctures could be found.

It was stated that the locusts had appeared at irregular intervals along a distance of ten miles in that vicinity, including the towns of Victor, Holcomb, Bloomfield, and East Bloomfield.

On June 25, a few locusts and their emergence holes were observed in the district about Padelsford and Martensia, but not in excessive numbers.

On June 21, the senior writer spent the day in the vicinity of Manchester and Shortsville, but was unable to find any traces of the insect. No report of any outbreaks had been heard of in either village, so far as could be ascertained. Lowe reported the insects as having occurred at Manchester in 1899.

Specimens were also received from correspondents in East Onondaga, Onondaga County.

Several individuals of this species were taken at Lake Ridge, Tompkins County, on June 16, 1916. Mr. Benjamin, who collected the insects, informs us that they were abundant over a district about ten miles in length and several miles in width of which Lake Ridge seemed to be the center.

It may be noted that in no case were any of the so-called "cicada turrets" observed, among the thousands of exit holes seen by the writer.

The writers are indebted to Professor P. J. Parrott for the following additional records of the occurrence of the insect:

Livingston County—Groveland.
Ontario County—Billsboro and Ionia.
Onondaga County—Onondaga Valley.
Yates County—Dresden and Earls.
Monroe County—West Webster.

Vice-President G. A. Dean: Is there any discussion?

Mr. P. J. Parrott: I am very much interested in this paper presented by Mr. Hadley. While we did not devote much time to the study of the insect, our attention was called in several instances to large numbers of Cicadas in apple orchards. The occurrence of the species in old apple orchards is certainly deserving of mention. At the time Mr. Hadley was watching the insects in orchards about Holcomb, we evidently were similarly occupied in orchards to the north of this locality in the region of Victor. Here there are many old orchards and the opinion generally prevailed that this was the third visitation by the insects. We made several trips to this locality to note the times of appearance of the different stages and the work of the adults on apple wood. In some old apple orchards the insects were present by tens of thousands, and in one orchard neighboring farmers were summoned to destroy the nymphs as they ascended the trees. We noted oviposition on peach and apple. On account of the large numbers of Cicadas that made their appearance on fruit trees we were able

to carry on a spraying test with Bordeaux mixture, to which was added a large amount of lime—60 to 80 pounds to 100 gallons of the mixture. In this connection it is of interest to note that the spraying did not apparently deter the insects from ovipositing.

VICE-PRESIDENT G. A. DEAN: If there is no further discussion, we will listen to the next paper by Mr. J. J. Davis.

A CHEMICAL FEEDING ANALYSIS OF WHITE GRUBS AND MAY-BEETLES (LACHNOSTERNA) AND ITS ECONOMIC APPLICATION[1]

By JOHN J. DAVIS, *West Lafayette, Indiana*

The practice of hogging off corn, thereby saving the labor and expense of harvesting and marketing the crop and producing more pork from the crop, is becoming a common farm practice and the value of this procedure has been demonstrated by federal and state investigators. However, the additional value and utilization of hogs for the destruction of soil-inhabiting insect pests, more especially white grubs and cutworms, has been given but little attention and seldom consistently applied, although pasturing hogs in grub-infested fields has been more or less practised for the past hundred years.

Their fondness for white grubs is well known, being evidenced wherever unringed hogs have been turned into pastures and their utilization for the eradication of grubs has been excellently shown by Dr. S. A. Forbes who reports[2] the destruction of 99 per cent of the grubs in a ten-acre, badly infested cornfield after being pastured for twenty-seven days with 100 pigs and 8 sows.

Notwithstanding these demonstrations, farmers have been slow in making use of hogs for the control of grubs, largely because their fields are not hog-tight and it therefore becomes necessary to prove the practicability and profitableness of the practice beyond the simple eradication of insect pests. Consequently a chemical feeding analysis of the grubs and May-beetles was made by Messrs. C. Cutler, J. H. Roop and M. S. Libbert, through the coöperation and courtesy of Mr. W. J. Jones, state chemist of Indiana.

The analyses as furnished us by Mr. Jones, which were made from one- and two-year-old grubs and recently matured adults, respectively, collected in the fall of 1916 behind plows, together with the analysis of dent corn as given by W. A. Henry,[3] follow:

[1] Published by permission of the Secretary of Agriculture.

[2] On the life-history, habits and economic relations of the white grubs and May-beetles. Bul. Ill. Agr. Expt. Sta., No. 116, Aug. 1907, p. 478.

[3] Feeds and Feeding, 1910.

Sample No. Material	Z–23 *Lachnosterna* grubs	Z–24 *Lachnosterna* adults	Corn
Moisture per cent	79.9	69.4	10.6
Crude fat per cent	3.1	4.9	5.0
Crude protein per cent	11.1	20.1	10.3
Crude fiber per cent	1.6	3.7	2.2
Crude ash per cent	2.0	1.6	1.5
Nitrogen free extract per cent	2.3	0.3	70.4

Comparing with other feeds the fat and protein contents of the grubs compare favorably with these constituents in corn, as indicated above, but the carbohydrates are deficient, indicating that feeding corn in connection with pasturing hogs in grub-infested land or, better, pasturing hogs in such land having a stand of corn, is desirable and a good practice.

To our knowledge only one chemical analysis of May-beetles has been published and this analysis (of *Melolontha vulgaris*) which was made by Stöckhardt in the Academy of Forestry of Tharand in 1856 to determine their fertilizer value and published by Lunardoni [1] is herewith given for comparison.

Material	Fresh May-beetles	Dried May-beetles
Nitrogen	3.23	9.6
Fat	3.80	11.5
Other organic substances	24.77	74.7
Mineral substances formed especially out of the components of phosphoric acid K_3PO_4, K_2CO_3, and $C_2P_2O_8$)	1.40	4.2
Water	66.80	0.0
Total	100.00	100.00

Reducing to similar terms, the above analysis, made over half a century ago, compares favorably with our analysis of May-beetles, as follows:

Material	*Lachnosterna* adults	*Melolontha* adults
Nitrogen	3.22[2]	3.23
Fat	4.9	3.80
Other organic substances	20.88	24.77
Ash	1.6	1.40
Water	69.4	66.80
Total	100.00	100.00

In the white grub infested areas there is an average of 106,680 grubs per acre. The grubs during the fall of their destructive season aver-

[1] Agostino Lunardoni, Gli Insetti Nocivi. *In* La Scienza e la Pratica Dell' Agricoltura, voi. XI, 1899, pp. 119–157.

[2] The nitrogen content in the protein.

age one gram each and the beetles slightly less, so that each infested acre contains approximately 235 pounds of grubs which have a food value of more than $3, that is, $30 for ten acres, enough to pay for fencing the field with hog-tight wire. In addition to the value of the grubs as hog feed the value of the manure produced should also be considered. In his bulletin, "The Growing and Fattening of Hogs in the Dry Lot and on Forage Crops,"[1] Prof. E. S. Good quotes Dr. H. S. Grindley as authority for the information that 85 per cent of the fertilizing constituents taken in by hogs as food is eliminated in the urine and feces for the entire life of the animal, being greater for mature individuals. In other words, $8\frac{1}{2}$ pounds of nitrogen is given off in the manure for each 10 pounds taken in as food and approximately 3.56 pounds of nitrogen alone would be given off in the manure produced by grubs eaten from one acre of ground, or 4.38 pounds if beetles were eaten.

To further illustrate the fertilizer value of the grubs it may be noted that the nitrogen content contained in the protein is 1.78 per cent of the entire analysis in the case of the grubs and 3.22 per cent in the case of the beetles and in addition the ash is heavy in phosphoric acid although the exact amount has not been ascertained.

Three objections have been raised to the use of hogs in grub-infested ground, especially in the case of pastures, namely, lack of hog-tight fences, rooting up of pasture land, and possible infestation with the giant thorn-headed worm, an intestinal worm affecting hogs. The first objection has already been answered. Observations indicate that an infested pasture, although badly overturned by rooting hogs, reseeds itself the following season with no ill effect other than a roughing of the surface which is of little significance. The last objection relative to possible infestation with the giant thorn-headed worm (*Gigantorhynchus hirudinaceus* = *Echinorhynchus gigas*) is of considerable importance. The white grub is an intermediate host of this worm which seems capable of entering hogs only by being taken into the body with grubs eaten. However, as a rule, no trouble will result from these worms if hogs which have never been pastured are used in fields which have not been previously pastured with hogs within three years. Care should be taken to prevent brood sows from running in fields likely to contain grubs infested with thorn-headed worms, that is in fields which have not been hog-pastured the previous season or two, but hogs being fed for market, according to our observations, can, with possible exceptions of very young pigs, be pastured with less regard for the past history of the field since they are usually marketed before the effect of the worms, if any are present, become harmful.

[1] Bul. Ky. Agric. Exp. Sta. No. 175, Apr. 1915, p. 332.

The advantages of pasturing hogs in grub-infested land in addition to the advantages advanced by swine experts regarding ordinary pasturing of hogs may be summarized as: 1. Eradication of grubs which might otherwise destroy the crops planted on the ground. 2. Value of the grubs as hog feed which is comparable with feeds costing $25 to $35 per ton. 3. Value of the manure distributed over the land, which has a money value, according to the experts of the Federal Bureau of Animal Industry,[1] of $3.29 per ton.

Vice-President G. A. Dean: Is there any discussion?

Mr. G. W. Herrick: I would like to ask Mr. Davis if the adults have been fed to hogs.

Mr. J. J. Davis: Only when they are found in infested fields; that is, during the fall of the year that they change to beetles. Hogs will search for beetles in the soil just as freely as for grubs.

Mr. G. W. Herrick: Were there any poisonous effects?

Mr. J. J. Davis: Absolutely no poisonous effects to my knowledge.

Mr. H. E. Smith: The table shows a high content of crude protein. Has anything been done about determining the digestible protein content. That is what the farmers are interested in as it is a most important factor, and a statement of crude protein is likely to be misleading.

Mr. J. J. Davis: I cannot answer that. All feeding materials are analyzed in this way and the protein content spoken of as crude protein. Apparently the digestible protein content cannot be determined by a feeding experiment. I might add a word relative to the non-injurious effects of the grubs on hogs. Dr. Forbes in one of his bulletins records pasturing 108 hogs in an enclosed 10 acre field badly infested with white grubs. In 27 days less than 1% of the grubs remained. If we figure 34.6 grubs per hill, the count made at the beginning of the experiment, it is easily calculated that the pigs destroyed approximately 1,217,083 grubs in 27 days. That is 11,278 or possibly 24 pounds per animal which, by the way, suffered no ill effects from this large amount of grubs.

Mr. G. W. Herrick: The reason I asked was that some experiments in feeding rose bugs proved poisonous to chickens and I did not know but what similar results might occur in feeding May-beetles.

Mr. J. J. Davis: No poisonous effect has ever been noticed from feeding Lachnosterna beetles to hogs or chickens to my knowledge.

Vice-President G. A. Dean: Mr. Joseph H. Merrill will now present the next paper.

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[1] Weekly News Letter, U. S. Dept. Agr., vol. IV, No. 17, Nov. 29, 1916, p. 3.

1. Blight canker containing aphid eggs.
2. Method of caging aphids on twigs.
3. Check twig on left; blighted twig on right.
4. Blighted twig.

FURTHER DATA ON THE RELATION BETWEEN APHIDS AND FIRE BLIGHT (BACILLUS AMYLOVORUS BUR. TREV.)[1]

By J. H. Merrill, *Assistant Entomologist, Kansas Agricultural Experiment Station*

In the Journal of Economic Entomology, Vol. 8, No. 4, 1915, a report was given of field observations made on the relation of aphids to fire-blight in Doniphan County, Kansas, for the years 1913, 1914 and 1915. In 1915 and 1916, observations were carried on in Atchison as well as in Doniphan County, and in both counties a direct relation was found to exist between the severity of the aphid infestation and the amount of fire-blight infection.

It was planned to carry on experiments during the spring and summer of 1916 to determine two points—(1) how it was possible for the aphids to come in contact with the blight bacteria, and (2), whether or not the aphids could inoculate trees with fire-blight.

To determine the first point, a large number of hold-over cankers were examined and it was found that the aphids deposited their eggs in blight cankers (Pl. 2, Fig. 1) as readily as in any rough places on the bark. In the spring, the live cankers resume activity, giving forth gummy exudations filled with bacteria. The aphids, which hatch from eggs laid in the cankers, crawl through these exudations in passing to the terminal growth of the twigs and, in so doing, become contaminated with blight bacteria.

To determine the second point, it was planned to secure a large number of aphids, allow them to pass over pure cultures of blight bacteria, and then transfer them to the twigs of apple trees. Owing to the fact that aphids were very scarce in Kansas during the summer of 1916, none were obtained for this work until August.

During the month of August, the average maximum temperature at the field insectary at Manhattan, where these experiments were being conducted, was 96.5 degrees and the total rainfall for the month was .71 of an inch. Naturally, the trees put forth but very little new growth during this period.

Despite these adverse weather conditions, aphids, which had previously passed over pure cultures of blight bacteria, were placed on the twigs of four Yellow Transparent trees and these twigs covered with cheesecloth bags (Pl. 2, Fig. 2) to prevent other insects gaining access to

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 21. This paper embodies the results of the investigations undertaken by the author in the prosecution of project No. 13. Kansas Agricultural Experiment Station.

them. On the same date, transfers were made by a sterile needle from a pure culture of the organism to lesions in the succulent growth of several other twigs. Although observations were made on all of these trees until the 13th of October, no traces of blight were noticed. On the 25th of August, infected aphids were placed on four Yellow Transparent and four Jonathan trees, but the results were similar to the first experiment.

During the month of September, the average maximum temperature was 80.3° and the total rainfall was 8.12 inches. The apple trees now began to put forth new, tender growth, producing conditions more nearly approximating those of spring when blight is ordinarily more prevalent.

On the 25th of September, infected aphids were placed on nine Yellow Transparent, two Jonathan, one Delicious, one Winesap, and one Ben Davis apple trees. Although brown spots appeared on the leaves and terminal buds of some of the Yellow Transparent trees, no clear cases of blight were discovered. On the 7th of October, the Jonathans began to exhibit signs of blight, which became well developed cases by the 10th of October. The other varieties did not blight.

During the first thirteen days of October, while observations were being made on these trials, the average maximum temperature was 77 degrees and the total rainfall for that period was .9 of an inch. The apple trees developed considerable new growth during the early part of the month. On the 3d of October, infected aphids were placed on three Jonathan and four Yellow Transparent trees. The blight made its appearance on October 5 when the leaves began to turn brown, increasing daily until, on the 13th of October, all of the twigs showed well-developed cases of fire-blight (Pl. 2, Figs. 3 and 4).

Summary

1. The blight developed only in the tender succulent growth on the twigs.

2. By hatching from eggs laid in blight cankers, the aphids come in contact with the fire-blight organism.

3. Aphids can and do inoculate trees with the bacteria of fire-blight.

4. The amount of fire-blight infection in an orchard may be materially decreased by destroying all of the aphids which may appear there.

Vice-President G. A. Dean: This paper is now open for discussion.

Mr. M. T. Smulyan: I would like to ask what species of aphids were utilized in these experiments.

Mr. J. H. Merrill: Green.

Mr. M. T. Smulyan: I would like to ask if any other species were used.

Mr. J. H. Merrill: Those were the only ones I was able to get this year.

Mr. M. T. Smulyan: You cannot say then what species is most responsible for carrying the blight.

Mr. J. H. Merrill: In Kansas the blight cankers resume their activity just before the trees leave out in the spring, and at that time it is the green aphis which is present and enters the buds as they open and works its way into them. They may very easily inoculate the trees with the blossom blight by so doing.

Vice-President G. A. Dean: If there is no further discussion, we will listen to the next paper by Mr. Quincy S. Lowry.

AN OUTBREAK OF THE EIGHT-SPOTTED FORESTER, ALYPIA OCTOMACULATA FABR., IN NEW HAVEN, CONN.

By Quincy S. Lowry, *New Haven, Conn.*

On July 22, 1916, the writer, by request, visited the estate of Mr. E. A. Prince at 498 Howard Avenue, New Haven, to inspect his grape arbors which were being rapidly defoliated. Thousands of caterpillars, mostly full grown, were found feeding on nearly all kinds of foliage in the yard, but were especially abundant upon the grape and Virginia creeper. These proved to be larvæ of the Eight-Spotted Forester, *Alypia octomaculata* Fabr.

Due to the fact that this is a common insect, no detailed description is necessary here. It might be stated that it is a conspicuous naked caterpillar, the head being yellow, dotted with black, the segments rather brilliantly marked crosswise with orange, black, and white bands, each segment also having a row of black dots. There is near the tail a rather prominent hump on each side of which is a light yellow spot, rhomboidal in shape; smaller yellow irregular lateral markings are noticeable just above the spiracles and between the orange cross-bands. The full grown larvæ are about one and one-half inches in length.

The grape is the favorite food of this species, though it feeds readily on Virginia creeper, *Ampelopsis quinquefolia* Michx. The larvæ were also found feeding on the common barberry, *Berberis vulgaris* Linn., and different varieties of rose.

Nothing had been done up to this time (July 22) to prevent the ravages of the caterpillars and there was scarcely any food available, the arbors and also the Virginia creepers being completely defoliated.

Mr. Prince had a Virginia creeper which was used as a screen and covered the entire end of the piazza, which did not have a leaf on it at this date. The new clusters of fruit on the grape arbors were badly eaten as well as the foliage.

A great many larvæ were collected and brought to the laboratory, but the majority of these did not live. Consequently, more larvæ were collected from the same locality on July 28. As Mr. Prince had sprayed everything on his premises with arsenate of lead, which proved to be most effective, it was difficult to find any living larvæ, though plenty were present in adjoining yards.

All of the arbors within a radius of a mile were in the same general condition. However, outside of this district there was no other complaint made in Connecticut. It seems to be a well-established fact that this insect is rarely found in vineyards or arbors located in the country, but only in the city yards. At the Experiment Station farm, located at Mt. Carmel, a grape arbor was inspected several times and no trace of the Eight-Spotted Forester found; neither had there been any complaint from nearby towns such as Yalesville and Meriden where there are several vineyards.

On August 2, the majority of the larvæ collected on July 28 had gone into the sand in the breeding cages. The adult moth will not emerge until spring. The wings are velvety-black and have two large pale yellow spots on the forewings and two smaller white spots on the hind wings. The first and third pair of legs are tufted with orange.

Two Tachinid parasites emerged August 15, and were identified by Mr. Harrison E. Smith of the Bureau of Entomology as being *Winthemia quadripustulata* Fabr. It is a question as to whether this insect will cause damage in the same locality another year, and also if the parasites will keep it in check.

The writer has been unable to find any publication which figures the Eight-Spotted Forester as being of much economic importance, and only brief accounts of this insect have been published recently, all of which simply mention it as feeding on grape and Virginia creeper. It seems from the outbreak in New Haven, that considerable damage and financial loss would be caused if this insect became abundant in a commercial vineyard.

Vice-President G. A. Dean: The next paper will be read by Mr. George G. Becker.

NOTES ON THE PEACH-TREE BORER (SANNINOIDEA EXITIOSA)

By Geo. G. Becker, *Fayetteville, Ark.*

Before taking up the subject of this paper the writer wishes to make acknowledgments to Messrs. W. C. Quick, W. D. Merrill and William Lee, who, as student assistants under his direction, made a great many of the observations recorded in this paper.

Most of the notes are made on pupation, and on the emergence and habits of the moths.

Pupation

Attempts were made to ascertain the time required in spinning up, the time spent as larva in the cocoon and the time spent in the cocoon in the actual pupal stage. The problem was fraught with some difficulties and the data here offered are at best more or less fragmentary.

As long as four days may be required to construct a cocoon, though it appears that with average larvæ this does not require more than a day.

After spinning up in its cocoon the larva remains in this stage for a period of 5 to 9 days. During this time it doubtless works for a day or so finishing up the interior of its cocoon and then rests awhile before transforming to the pupal stage. We had one larva spin its cocoon and transform to the pupal stage in six days.

The duration of the pupal stage within the cocoon appears to be about three weeks, though here again there seems to be a variation with individuals. One individual which was observed as a tender white recently transformed pupa emerged 13 days later as an adult, thus requiring only 13 days for its pupal stage. Our observations lead us to the conclusion that the time which elapses from the time that the larva spins its cocoon to the time that the moth emerges ranges from 18 to 30 days.

Emergence

Emergence from the pupal stage was watched with considerable interest and from the observations of 1916, which need to be verified, it appeared that there were four stages of emergence.

Emergence occurred from 6 to 10 a. m., but was apparently most active from 8.30 to 9 on bright clear days. Doubtless this would vary with the time of the year when emergence took place, being earlier on long days than on the shorter and cooler days later in the season.

Atmospheric and light conditions seemed to be the factors governing emergence after the pupæ were mature for the transformation, though light seemed to be the more important.

In the case of pupæ kept under cover in the insectary it was found that darkness retarded emergence. On a day when it was raining at intervals, moths were observed emerging with the sunny spells when the inverted box was removed from over them.

A pupa which was at the stage ready for pupation, was brought into the laboratory and induced to emerge by subjecting it to the rays of an arc light.

Stages of Emergence

Stage 1. It was observed in the case of pupæ which would emerge on a certain day that there was a small tear across the top of the cocoon which indicated in advance which ones would be likely to emerge that day. Pupæ having such a tear would likely emerge that day though unfavorable weather conditions would cause emergence to be postponed until conditions were again favorable. When a tear was not observed until after the normal time of emergence the insect would not pupate until the next day.

Stage 2. If one will observe a pupa, as described for stage 1, at the right time (8 to 9 a. m.) on a clear day, the rift across the top of the pupal case will be observed to suddenly widen and the pupa will be seen pushing steadily out of the case until it is about one-third way out. This only requires on an average about $2\frac{1}{4}$ minutes. Following this the pupa rests for a period of about twenty minutes before undertaking the next stage of its emergence.

Stage 3. Following this rest comes another pushing upward frequently accompanied by a sort of circular, twisting movement. By this time the pupa has pushed itself from one-half to two-thirds way out of its case. Frequently when they have gotten on this far pupæ will be observed going through this circular, twisting movement which Cory noted in his observations. In doing this a pupa may twist itself out of its cocoon, in which case emergence from the pupal skin seems to be difficult. The second stage of emergence requires about five minutes.

Stage 4. The pupa rests only a few seconds after it is two-thirds way out of its case and then starts to push through its pupal skin. One may observe through the pupal skin that all the body seems to be crowded forward in order to exert as much pressure as possible on the back of the thorax. In the case of females the bright orange band on the abdomen will be observed to move one segment forward under the pupal skin. Suddenly the skin splits over the thorax and the top of the meso- and meta-thorax pushes out, followed by the head. The antennæ are then drawn out and are almost immediately followed by the prothoracic legs. This done, the pressure seems to be released and the insect has apparently no difficulty in wriggling out of the skin.

The process of emergence, once the skin is split, requires only 20–35 seconds. After emergence the insect crawls up on top of its deserted pupal skin, on the trunk of a tree or clod of dirt. At this stage the wings are plastered down on the back. In about 15 minutes the wings begin to raise up off the body and have the appearance of becoming inflated. This requires several minutes. During this the wings gradually straighten out and assume shape. Following this they are waved a time or two and are then held vertically over the back for about five minutes. They are then brought down over the back as in the normal insect when at rest and in about twenty minutes, in the case of the moths which we observed, the insect is ready for flight.

Date of Emergence

Records on the date of emergence yielded some interesting results and suggested a line of investigation which might bring some interesting facts to light if it could be interpreted with careful temperature, humidity and other climatological records.

The records were made by going over the same orchard at intervals of three to seven days and collecting all the pupal skins which appeared around the bases of the trees since the last observations. All rubbish, etc., was cleared from around each tree before the first observation was made. Pupal skins collected at each observation would then indicate the number of moths which had emerged since the last observation.

Since practically all of the borers pupate either right at, or within a radius of two inches of the tree and since the pupal skins are usually held fast to the cocoon for some time after emergence, it would be possible to get a rather accurate record of emergence.

Regarding the pupation of the insect and their emergence with reference to the tree, the following data on 258 insects are offered:

	No.	Per cent
Pupated and emerged from trunk of tree	5	2.
Pupated in and emerged from soil immediately against tree	102	39.5
Pupated in and emerged from soil within a radius of 1 inch from trunk of tree	114	44.
Pupated in and emerged from soil within a radius of 1 to 2 inches from trunk of tree	22	8.5
Pupated in and emerged from soil within a radius of 2 to 3 inches from trunk of tree	8	3.
Pupated in and emerged from soil within a radius of 3 to 4 inches from trunk of tree	5	2.
Pupated in and emerged from soil at a distance of 6 inches from trunk of tree	1	.5
Pupated in and emerged from soil at a distance of 8 inches from trunk of tree	1	.5

A study of our date of emergence records indicates that in the Ozarks adults may be on wing any time from the last of May to the last of October. In 1911 a ♂ moth was seen on wing in the orchard on the 29th of May and in 1912 four moths of the 284 recorded in that year's records emerged from October 26–30. In general, however, it will be noticed from the data that 60 to 93 per cent of the emergence takes place within a period of about four weeks—from the middle of August to the middle of September. Before this period emergence is light and sporadic and after this period there are only a few stragglers.

1910. In the records of this year on 350 insects there was a slow and sporadic emergence up until August 23. An interesting rise occurred however, from July 23 to August 5, during which time 25.1 per cent. of the emergence of the season occurred. This rise seemed abnormal, and it was at first thought that there might be two broods of borers concerned in this orchard. A study of the 1912 and 1913 data, taken in the same orchard, would hardly bear this out.

After this brief rise emergence dropped off until August 23 when it began to rise abruptly. Within the week following August 23, 27.1 per cent of the emergence occurred and from September 1 to 20, 54.3 per cent of the moths emerged. After this date emergence dropped off abruptly.

1911. The data of this year is very meagre and was taken from a different orchard, from which only 63 moths emerged; 48.1 per cent of these emerged from August 23 to September 4, emergence being heaviest from August 29 to September 4.

1912. Our records of this year are on 284 skins collected from July 1 to October 30. Emergence was irregular and scattered until August 23 with a slight rise from August 1 to 7, inclusive. From August 23–26 only four moths emerged, but within the next three days there was a rapid rise, 34 moths having emerged, and in the three days following this, August 26–29, sixty-nine moths emerged. The record illustrates well how rapidly emergence rises, it being 4, 23 and 69 at three-day intervals from August 23. The active period of emergence for this year was from August 27 to September 16, during which time 79.5 per cent of the emergence occurred.

1913. Emergence of this year was made on a basis of 405 moths. As in other years there was a scattered and sporadic emergence up until the middle of August. From August 4–11 only two moths emerged, in the week following 25 emerged, in the four days following this, August 17–21, 34 emerged and in the four days following this, August 21–25, 69 emerged. The emergence of this year was characterized by being more concentrated in the period of maximum emergence. This period was steadier and more prolonged than in other

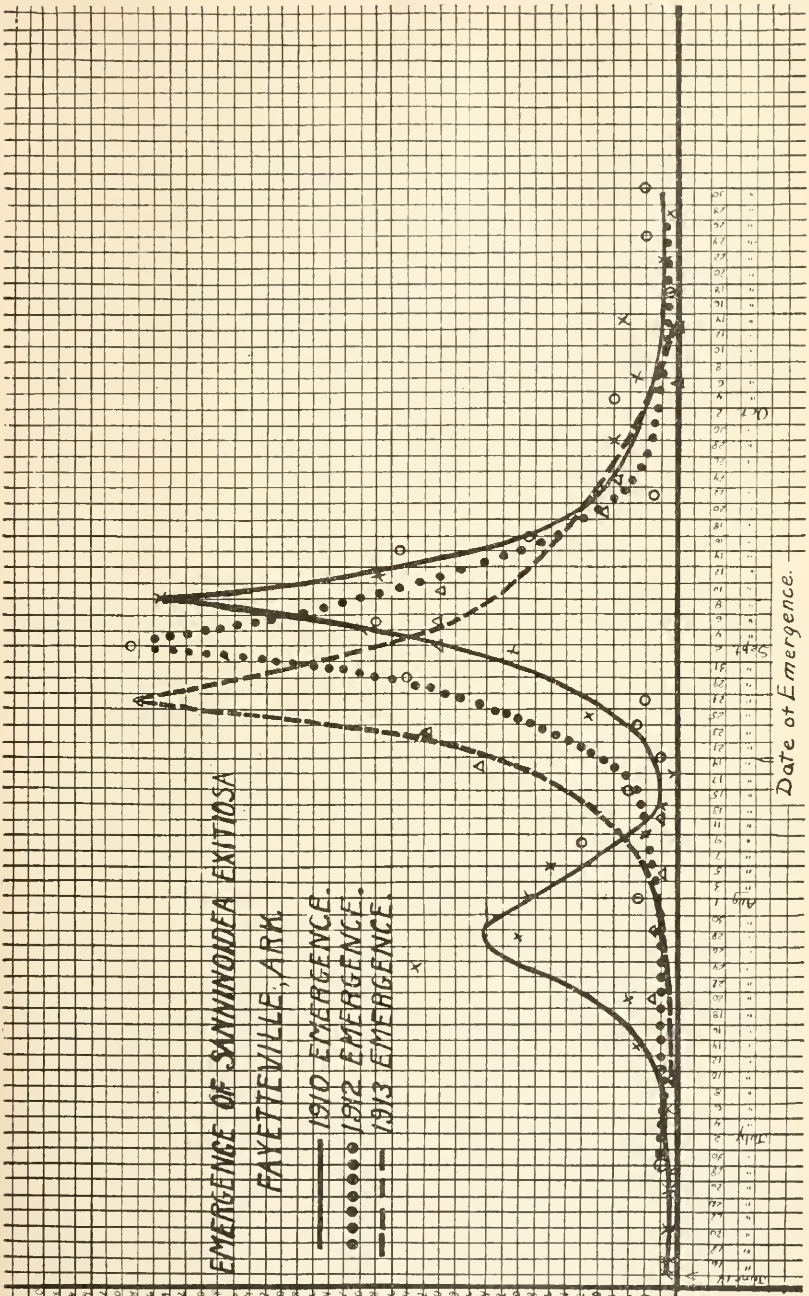


Fig. 1. Emergence of peach borer, *Sanninoidea exitiosa*.

years. It will be observed that between September 12 to 16 there was an emergence of 55 moths. After this it dropped off very abruptly. 93.3 per cent of the 1913 moths emerged from August 18 to September 16.

After 1913. Unfortunately we have no complete records for the years following 1913. The work was interfered with by other projects. A record on 75 moths for 1915, however, indicated a concentrated emergence from September 2–8.

Taking the crest of emergence as the date when half of the insects of that season had emerged, and this date coincided with remarkable accuracy to the date when, as far as numbers go, the emergence is at its zenith, we find that the crest for the different years at Fayetteville was reached as indicated in the table below:

Year	Date of crest
1910	Sept. 8
1912	Sept. 2
1913	Aug. 29
1915	Sept. 5

It will be observed that there is a range of ten days for the crest of emergence. The data of 1910, 1912 and 1913 was taken from the same orchard, but the records of 1915 were made on the basis of seventy five pupæ collected before the date of maximum emergence, and bred out in the insectary.

A period of fifteen days on each side of the crest will embody the period over which the maximum emergence takes place and during which time from 60 to 93 per cent of the emergence takes place. If the 1910 data be considered abnormal, it might be said that 75 per cent or more will emerge during this period.

Emergence at Different Points in the State. Limited data were obtained to determine the difference in emergence at Fayetteville, latitude of 36° N., at an elevation of 1425 feet; at Abbott, latitude 35° N., and elevation of 580 feet, and El Dorado, Ark., latitude 33° 10′ N., with an elevation of 265 feet.

El Dorado. Records from this place are by no means complete and the data will need considerable reinforcement before we can have anything conclusive. In these records pupæ were collected just after practically all of the worms had pupated and before emergence had begun to any extent. The crest of emergence for 1914 on a basis of 62 insects was on August 24, in 1915, on a basis of 69 insects, it was August 26, and in 1916 on a basis of only 22 insects it was August 22.

The data at *Abbott* were procured in the same way as at El Dorado.

On the basis of 29 moths the 1913 crest of emergence was September 7, and in 1914, on a basis of 94, it was August 31. It is not impossible that the change in elevation and, to a lesser extent, latitude, may have influenced the Abbott and El Dorado emergence records.

Getting our records as we did, however, it would appear that emergence at El Dorado is ten days earlier than at Fayetteville, while at Abbott in 1913 emergence was actually ten days later than the Fayetteville average (September 4) and in 1914, four days earlier.

In connection with the 1913 Abbott data it might be well to note that it was made on a basis of only 29 moths and could hardly be considered as representative. The 1914 data was on a basis of 94 moths and is considered more representative. As further evidence of the difference between these different points I find in my notes of August 16 and 18, 1913, made at El Dorado and Abbott, respectively, this note: "From the general condition of the pupæ and the proportion of larvæ to pupæ, indications are that Abbott is about one week behind El Dorado on emergence." The 1914 data would bear this out. Following is a table of comparison of the crests of emergences.

Location	1910	1912	1913	1914	1915	1916
Fayetteville	Sept. 8	Sept. 2	Aug. 29	....	Sept. 5	....
Abbott	....	....	Sept. 7	Aug. 31	....	....
El Dorado	....	....	....	Aug. 24	Aug. 26	Aug. 22

It would seem that we are warranted in concluding from the data that the emergence at El Dorado, a point nearly 3° south of Fayetteville and with a difference in elevation of about 1200 to 1300 feet in favor of Fayetteville, that emergence is certainly one week earlier and probably ten days, while at Abbott, a point 1° south with a difference of 864 feet elevation in favor of Fayetteville, there is enough to suggest that emergence is four days ahead of Fayetteville.

Annual Variation in Abundance

Although it would appear that the peach tree borer would not be as subject to temperature, humidity and other weather changes as an insect living out in the open, the emergence records of 1910, 1912 and 1913 made from the same trees, show an interesting variation in the number of insects which bred to maturity in these years.

It would seem that this variation would have its explanation to some extent, at least, in a careful study of climatological variations. In this instance the fluctuation may be due to changes on the condition of the trees, rather than on the insect. In 1910 there were 350 insects to breed to maturity in the orchard which was studied. In 1912, 287 bred to maturity and in 1913 there were 405 to breed to maturity.

Proportion of Males and Females

A little data was accumulated to determine in what proportion the sexes occurred. Following is data which was collected from El Dorado and Abbott material.

Locality	No. Males	No. Females	Per cent Males	Per cent Females
El Dorado, 1913	17	13	56.6	43.4
El Dorado, 1914	27	32	45.7	54.3
Abbott, 1914	34	60	36.2	63.8

The data would indicate that males and females usually occur in equal numbers, but that there might be a variation with the season.

Activities of Moths

Period of Activity. Usually moths are active during the heat of the day. Beginning with emergence as early as 6 a. m. most of them will emerge at from 8 to 9.30 a. m. and by 10 a. m they are usually in coitu. After copulation moths are usually on wing and quite active until about 4 p. m. and by 5 p. m. they are frequently quite sluggish.

Copulation. Moths were observed in coitu, under caged conditions as early as 8 a. m. though the normal time seems to be at 10 a. m. Moths have also been seen in coitu as late as 2.20 p. m. though this is not generally the rule. Copulation in average cases seems to last one hour though we have observed it to last one hour and a half.

Oviposition. In most cases the female begins to oviposit shortly after copulation, but frequently immediately after. Oviposition occurs usually during the warm part of the day, from 10 a. m. to 4 p. m. After this time oviposition drops off. We have observed individuals apparently attempting to oviposit after 5 p. m., but in no case did we actually observe them deposit eggs.

When a female is observed ovipositing she will be seen to wave her ovipositor from one side to the other over the bark. Mr. Lee observed the process of oviposition with a lens and found that the female had fine hairs on the tip of the ovipositor which hairs were in touch with the bark. With these hairs she was able to locate little cavities and irregularities in the bark and in such places she deposited her egg. It is to be noted in this connection that eggs are almost always deposited in little crevices, or, at any rate, not on elevated places of the bark. Frequently the female feels for an egg which she has deposited and deposits another beside it.

The actual act of depositing the egg does not seem to take more than five to ten seconds. A female was timed to see how many eggs she would deposit in a minute. Once she deposited ten eggs, again five, and a third time eight eggs. The number of eggs per minute

depends upon how long it takes the female to find suitable places for her eggs.

Usually a number of eggs are deposited together when they are being deposited on a tree trunk. On leaves, however, they are more frequently deposited singly.

Usually a moth alights at the base of a tree, deposits a few eggs, crawls to the side and deposits a few more, or else they crawl up the trunk, depositing eggs at intervals of one to two inches as they go.

It is of interest to note in this connection that moths seemed to dislike trees which were treated with asphalt. Frequently they shunned such trees and it was observed that they seemed to deposit eggs on the leaves of asphalt treated trees rather than at the base. One moth, however, was observed to deposit eggs in cracks of an asphalt coating.

Moths were found to deposit on trunks, twigs and leaves of peach trees as well as on weeds and clumps of dirt. Mr. Merrill observed one female evidently making repeated and persistent attempts to deposit eggs on the back of a Sphingid larva.

From our observations we concluded that about 50 per cent of the eggs were deposited at the base of the peach tree, 34 per cent a little higher up on the trunk, 3 per cent on twigs, 10 per cent on leaves, 2 per cent on weeds and about 1 per cent on clumps of dirt, etc. These observations were made by following moths around in the orchard and counting the eggs every time they alighted for the purpose of ovipositing. We found it possible to follow moths through as many as five ovipositions. Many times the moths crawled from one part of the tree to the other in order to oviposit, so that records were easily kept in these instances.

Longevity of adults will be discussed at this point so that the number of eggs per female, per cent fertility of the eggs, etc., may be considered together.

In 1913 the average life of females experimented with under caged conditions proved to be 4.3 days. These moths were given neither food nor water, so that this would hardly represent the average life of an adult.

In 1916 moths were kept in cages with sweetened water, and it is believed that the duration of the adult stage under these conditions was nearly normal. Six females, three of which had copulated and three of which had not, lived on an average of 6.3 days. In these cases copulation did not seem to have any effect on the life of the individual.

Seven females, six of which had been fertilized, averaged 7.6 days. One of this number was an unusual moth. She lived 12 days and deposited 1072 eggs.

Prolificacy

Number of Eggs per Female. In experiments conducted in 1913 with females under caged conditions 8 females averaged 522 eggs. They were not dissected to see if they contained any additional eggs. It was thought that females under caged conditions would not deposit as many eggs as they would in the orchard and dissection of moths in 1916 showed that caged females, after they had died, contained a number of eggs.

Records of three moths made in 1916 yielded the following results:

	Number of Eggs Deposited	Number of Eggs Dissected	Total
No. 1	670	141	811
No. 2	426	297	723
No. 3	1,072	8	1,080
Average female	722	148	871

Although the 1916 data is on only a few individuals it would indicate that the number of eggs deposited by a normal female is higher than the 1913 experiments indicated. In the latter case the females were starved and, what is more, they were not dissected for eggs. An expectancy of 800 eggs per female would not seem to be unreasonable.

Fertile Eggs

Eggs from eight different females were tested to determine what per cent. of deposited eggs were fertile. The results appear in the table which follows:

No. Insect	No. Eggs Tested	Percent Fertile
1	517	98
2	974	98
3	587	98
4	358	98
5	386	96
6	450	99
7	665	89
8	464	100
Average female		97

Period of Incubation

In the laboratory the period of incubation for eggs was usually five days. But in the screened insectary, where eggs got the exposure of the sun for half the day, they hatched usually in about ten days. This was in August. In the orchard where eggs will frequently be

shaded so that they will not get all of the morning or all of the afternoon sun the period of incubation may be two weeks.

It will be seen from the figures given in this paper that an average female may be expected to deposit 800 eggs, 97 per cent. of which may be expected to be fertile and 84 per cent. of which are effectively placed. This would mean that there would be an average of 650 larvæ from each female which have a chance to mature. If the infestation of an orchard remained steady from year to year it would mean that 648 of these would fail to reach maturity. In other words, only one out of every 325 would reach maturity. This would mean a mortality of 99.69 per cent., or, made on a basis of all larvæ which hatched, there would be a mortality of 99.74 per cent.

With 650 larvæ to attempt to take the place of every pair of moths which bred to maturity, it is not difficult to see why tree protectors have failed to give the desired protection against the pest. If we were to take these figures we would find that a tree protector, in order to be 50 per cent. efficient, would have to keep out 649 out of every 650 borers which are trying to find a place to enter the tree and if the protector were 90 per cent. efficient the protector would have to exclude 3,249 out of every 3,250 borers. Although 3,240 out of the 3,250 would fail to breed to maturity under normal conditions, entomologists must realize what they are trying to do when they attempt to keep out the additional nine of this tremendous number of borers which are attempting to run the gauntlet of even a 90 per cent. efficient tree protector.

Vice-President G. A. Dean: Is there any discussion?

Mr. F. L. Washburn: It would be interesting to hear the method of taking the pictures showing the various stages of the insect.

Mr. G. G. Becker: The pictures were taken with arc light rays. Pupæ that were about ready to emerge, as indicated by a little rift which appeared across the top, were brought into the laboratory and then subjected to the rays of the arc light. Adjustments had previously been made so that on being subjected, they could be snapped at whatever stage was desired.

Vice-President G. A. Dean: Mr. Hugh Glasgow will present the next paper.

THE SINUATE PEAR BORER IN NEW YORK

By Hugh Glasgow, *Agric. Expt. Stat., Geneva, N. Y.*

(Withdrawn for publication elsewhere)

Vice-President G. A. Dean: The paper is now open for discussion.

Mr. H. T. Fernald: This paper has been interesting to me because I think it was at one of these meetings about ten years ago that the insect was first reported by Doctor Smith from New Jersey. Then it was only known in certain portions of that state. I would like to ask the speaker whether he can give us any indication of its present distribution in New Jersey which would indicate how far it has spread.

Mr. Hugh Glasgow: No, I cannot.

Vice-President G. A. Dean: The next paper will be presented by Dr. E. P. Felt.

"SIDE INJURY" AND CODLING MOTH CONTROL

By E. P. Felt, *Albany, N. Y.*

The term "side injury" or "shallow" is limited in this paper to the characteristic blemish produced by late-hatching codling moth larvæ entering the smooth side of the apple, running just under the skin a circular gallery with a radius of about one-sixteenth of an inch, and then in a few days deserting this initial point of injury and usually migrating to the blossom end. This blemish is frequently marked by a red or reddish brown discoloration and was the cause of serious loss in western New York in 1915. Then it was not difficult to find sprayed orchards with 20 per cent or more of the fruit affected in this manner. There was not so much damage of this character the past summer.

The experimental work of 1916 was a continuation of that of the preceding year and in tabulating results, pains were taken to distinguish between this "side injury" or "shallow" and other codling moth work.

We have brought together in the above tabulation, a comparison of conditions found in two Orleans County orchards—one Greening and the other King apples. It will be noticed, as in the Kendall orchard, that the yield for the plots of six trees sprayed once, twice and three times, varied in an almost uniform descending series from nearly 7,000 to approximately 1,500 apples, while in the Albion orchard, the range was from nearly 3,500 to approximately 6,400, the plot sprayed twice in the latter orchard being the one producing the smallest crop. We desire in this connection to call attention to the fact that the variation in the percentage of wormy apples appears to be affected more by the size of the crop than the number of sprayings and, moreover, that there is a fairly constant ratio between the total

Table I. Comparison of Wormy Apples in Kendall and Albion Orchards, 1916

Plot	Kendall Orchard (Greening)			Albion Orchard (King)		
	Total fruit	Total wormy	Shallow	Total fruit	Total wormy	Shallow
1 Total	6,838	662	339	5,755	606	267
Per cent		9.68	4.96		10.53	4.62
2 Total	3,064	266	180	3,477	384	245
Per cent		8.68	5.87		11.04	7.04
3 Total	1,450	207	175	6,419	540	381
Per cent		14.27	12.06		8.41	5.93
1–3 Total	11,352	1,135	694	15,651	1.530	893
Per cent		10.01	6.11		9.77	5.09
Checks Total	988	129	89	643	201	51
Per cent		13.05	9.00		31.25	7.93

wormy fruit and the apples showing side injury. In plot 1 for both orchards nearly one-half the wormy apples are affected in this manner, while in plots 2 and 3 and the checks for the Kendall orchard, it is practically two-thirds, with the exception of plot 3 for the Kendall orchard, where the reduction is approximately one-fourth, and this latter is equally true of the one check tree in the Albion orchard.

Table II. Comparison of Percentages Between Wormy and "Shallow" Apples, 1916

Plot	Kendall Orchard (Greening)			Albion Orchard (King)			Hilton Orchard (Baldwin)		
	Wormy	Approx. Shallow	Shallow	Wormy	Approx. Shallow	Shallow	Wormy	Approx. Shallow	Shallow
1	9.68	4.84	4.96	10.53	5.26	4.62	17.55	8.77	7.99
2	8.68	5.78	5.87	11.04	7.36	7.04	16.05	10.70	9.15
3	14.27	9.41	12.06	8.41	5.61	5.93	12.54	7.36	8.45
Ch.	13.05	8.60	9.00	31.25	20.83	7.93	10.87	6.25	5.93

In order to bring this point out more clearly, we have brought together in Table II, a comparison of the percentages between the total wormy and "shallow" apples in three orchards representing three varieties, namely, Greening, King and Baldwin, sprayed by different groups of men, though under the same general supervision and undoubtedly subjected to varied treatments in earlier years. They were all within twenty miles of each other and under very similar, if

not almost identical climatic conditions. This table shows that, with a few exceptions, which latter are to be expected, it was possible to approximate the percentage of fruit showing this side blemish, by taking a definite proportion from the percentage of total wormy. This for the three plots sprayed once, was one-half and for the plots sprayed two and three times and the check trees, one-third, with the exception of the check tree in the Albion orchard. This latter, as may be seen by referring to the first tabulation, bore a small crop and a very large number of wormy apples. The percentages calculated in this manner varied from the actual by less than one and in a number of instances by only one-half of 1 per cent or considerably less. This may be only a striking coincidence. It seems to us very probable that, broadly speaking, there is a somewhat definite relation between the "shallow" infested apples and the total wormy, and this would certainly be the case if the young codling moth larvæ reacted to an hereditary instinct and excavated a temporary mine in leaf or apple, as the case might be, before working into deeper tissues. It is not even suggested that the proportions mentioned above would apply to all orchards. The probabilities are distinctly against this, since there are undoubtedly years and sections where a much larger proportion of eggs is deposited on the leaves than on the fruit; for example, one branch in an orchard near Lockport was examined by Mr. L. F. Strickland, state nursery inspector, July 24 last, and on 38 apples he found four eggs, and on the 171 leaves only one, a condition by no means unusual in western New York, judging from our own observations.

The apparent reduction of one-sixth of the total infestation, the difference between one-half and one-third of the wormy apples is not necessarily an indication that the second spraying, applied about three weeks after blooming, is efficient to that extent in eliminating side injury. The mere fact that one-third of all the wormy show the shallow type of injury on both the plots sprayed two and three times, and the check trees, with the exception noted above, would raise a question as to the real significance of this variation. It is, practically speaking, comparatively slight and we believe that the probabilities are against this variation being especially significant. It is a source of regret that no conclusive date along this line can be submitted.

A similar condition obtains if we compare the yields of the experimental plots in the Kendall orchard for 1915 and 1916. It should be stated that the plots were identical, the treatment was the same in two successive years, and the crop on each plot was practically the same as the year before. Considerable more spray was applied in 1916 and the work was very thorough. The percentage of wormy

fruit on the plots sprayed once was reduced from 27.67 to 9.68, and that for the other plots in approximately the same ratio. This was likewise true of the "side injury" or "shallow" for the two years, so far as these could be compared, owing to the fact that there was a slight change in classification in 1916. The relationship between the two types of injury was so close that a proportion showing the percentage reduction in the total wormy and giving the percentage of "shallow" for one year would work out to very nearly the percentage of "shallow" for the second year. This was true not only of plots 1 and 2, but of plot 3 and the check trees. The complete data are not given here and the above is brought to notice as additional evidence bearing upon this general problem.

Generally speaking, the development of side injury is conditioned upon the deposition of numerous eggs after the apples have become an inch or so in diameter and smooth enough so as not to repel the parent moth. We are satisfied that by far the greater benefit comes from the spraying just after blossoming and that the "side injury" is in general proportional to the infestation of the orchard. Moreover, the probability of securing immediate results in checking this type of mischief is not good and we look for a material benefit from last spring's treatment in reducing the probabilities of extensive side injury in 1917.

Vice-President G. A. Dean: Is there any discussion on this paper?

Mr. E. D. Ball: I would like to ask Doctor Felt whether the statement to the effect that the "shallows" are from larvæ that later went into the calyx cups is from experimental data.

Mr. E. P. Felt: It depends a little on just what you mean by experimental data. We examined in 1915 a great many apples showing that type of injury. A considerable portion of them were empty, and in a number of instances we found young larvæ later working in the calyx. In one or two cases larvæ were to be seen half way between the "shallow" type of injury and the calyx and the mere fact that you can find so much of this "shallow" type of injury with no indication of serious injury leads us to believe that this is the logical explanation.

Mr. E. D. Ball: These results do not agree with our western work, but of course we did not work on any of those varieties of apples. We call these marks "blinds" in the West. We consider where we find a "blind" that it has been made by a larva which has died from some cause or other, and this view seems to be pretty well established for that region. When a young larva dies there is nothing left but the black head. Often four or five of these "deadheads" (as we call them)

have been found in a single calyx. The question whether larvæ migrate from one point to another is very interesting. Under extremely wormy conditions in the West as high as forty-two eggs have been found around each apple on an average tree. Under such conditions the finding of a larva in the calyx would not prove that it came from a "blind."

Mr. E. P. Felt: Doctor Ball asked me to explain. May I ask him to explain? If these are "deadheads" in a certain sense, why is it that we should have substantially the same percentage on our check trees as on our sprayed trees,—trees that have had no poison? I cannot get over that.

Mr. E. D. Ball: I saw that point at the time and cannot get over it either. This habit of the larva of coming out and exposing itself on the surface of the apple a second time is also hard to reconcile. We thought we taught it better than that.

Mr. E. H. Siegler: In connection with the control of the codling moth, I have been asked to make a few additional remarks upon the paper entitled "A Codling Moth Trap" which appeared in the last issue of the Journal of Economic Entomology. I have brought along the same illustrations which are shown in the Journal and also have a small model which I shall pass around for your inspection.

As you will note, the trap consists of a strip of burlap folded to three thicknesses and sufficiently long so as to encircle the trunk of the tree. The burlap is then covered with wire screen, twelve meshes to the inch, and is securely attached to the tree trunk. The principle of the trap is founded upon the fact that the codling moth larva can enter a smaller opening than through which the moth can escape. The larva enters the trap through one of the openings of the wire screen and spins its cocoon beneath the burlap. Finally, the moth upon emerging is trapped beneath the wire screen.

It is a well known fact that many codling moth larvæ may be captured beneath cloth bands attached to the trunk of the tree and this method has been employed more or less for many years. However, the labor involved in examining the bands so as to destroy the larvæ beneath has greatly limited this practice. With these facts in mind, it therefore seemed of prime importance to ascertain whether or not the codling moth trap would prove as attractive a cocooning place for the larvæ as the usual cloth band. In order to secure this data, twelve trees in a commercial orchard were selected and around the trunk of each a burlap band was placed. A strip of wire screen was then attached to the trunk so as to cover the burlap half way around the trunk. It will thus be seen, that by this arrangement,

the larvæ leaving the fruit on each tree were free to spin up either beneath the uncovered portion of the burlap or else to pass through one of the meshes of the wire screen in order to cocoon in the burlap beneath. Experiments of this nature were started upon two trees July 1, upon two additional July 14, upon four trees July 17, and upon four more August 22. Examinations were made July 5, 14, 17, 20, 28, and August 9, September 8, October 30. The total number of insects captured upon these trees was 1,582 of which over 49 per cent voluntarily entered the traps. Thus from the information at hand, it would appear that the trap will entice approximately as many codling moth larvæ as will the ordinary cloth band.

Another experiment included five trees, the trunk of each of which was completely encircled by a codling moth trap. Three of these traps were placed July 1, one July 5, and one on August 22. During the period from their placement until October 30, 601 individuals, including larvæ, pupæ and moths were captured.

The information upon the codling moth trap is by no means complete as yet, but the indications are that this device may be profitably used, especially in regions where the codling moth is abundant. The use of wire screen traps is not necessarily limited to the codling moth but may be extended so as to include other insect pests.

Mr. E. D. Ball: This seems to offer a possibility of great service in the badly infested regions. There are one or two suggestions, however, that I should like to make. First, that it would be better to put two or three strips up and down on a tree rather than a single encircling one, for fear that this would be left on and kill the tree. The second is that I was much pleased with the success Mr. Siegler was having in rearing codling moth larvæ in strips of corrugated board and I am wondering if this would not be still better than burlap in these trap bands.

Mr. E. H. Siegler: That is a good suggestion. However, there is greater likelihood of catching more larvæ if the trap completely encircles the trunk. There is, of course, no need of the trap until the trees come into bearing, at which age the wire screen is scarcely strong enough to cause girdling. As the trees grow older the possibility of girdling is still further removed.

I am inclined to prefer the burlap since it is more durable than the corrugated pasteboard. There is no occasion to remove the burlap band during the season, and it should therefore be of service for several seasons.

Mr. E. D. Ball: Where burlap is left out all winter most of the lint and short fibres are washed out and when a double fold of it is held up to the face one can read a newspaper through it. Larvæ will not

hide under anything they can see through. Burlap bands should be taken off and stored or else changed every year.

VICE-PRESIDENT G. A. DEAN: The next paper will be read by Mr. George G. Becker.

THE CONTROL OF THE ROUND-HEADED APPLE TREE BORER

By GEO. G. BECKER, *Fayetteville, Ark.*

The investigations discussed in this paper were carried out at Berryville, Arkansas, in an orchard which represented as bad an infestation of the Round-Headed Apple Tree Borer as has ever come to the writer's notice. From 50 to 75 per cent of the trees of this eight-year-old orchard had been killed by this insect, though the shallow soil may have been a contributory cause to the death of some of the trees. No trees could be found in the orchard which did not show the work of the borer.

In 1913, a few over 1,000 one- and two-year-old apples trees were set out in this orchard. Trees were set out five feet in rows and ten feet between the rows. There were 67 trees to a row, and three to four rows to a plot. Plots were set out in alternate middles, so that each would have a vacant middle on either side. White Lead Paint ,Sherwin-Williams' Pruning Compound, Screening, and Asphaltum, in varying combinations with oils, were tried out. Except for the screened trees, all were treated at Fayetteville and tied in bundles of 10 to 13 to insure that the different treatments would be well scattered out over the plots. It was thought that Asphaltum might have different effects on different varieties and, accordingly, all the tests were carried out with three varieties.

WHITE LEAD

Previous experiments with white lead were conducted by Professor Hayhurst, and the author, in 1911, but our data were not conclusive enough. Accordingly, ninety-nine trees were incorporated in the tests at Berryville. Four per cent. of the trees were infested, this representing a protection of 56.7 per cent. Hayhurst, in 1911, found that beetles confined in a cage with twigs coated with white lead, ate through the paint. It is not unlikely that this would happen in the field. Our experiments on white lead were not continued a second year. From our tests we concluded that:

1. Trees would have to be retreated each year.
2. The protection obtained was not commensurate with the cost.

Pruning Compound

A paint by-product, known as Sherwin-Williams' Pruning Compound, was tried in the tests. It was thought that this material might be as efficient as white lead, and at the same time would be cheaper. Ninety trees were treated, of which ten were infested, representing an infestation of 11.1 per cent, and a protection of −3.7 per cent. In other words, these trees were more heavily infested than the checks. Beetles ate through the paint and the material cracked and flaked badly, and it was not considered worthy of a second trial.

Conclusions: Sherwin-Williams' Pruning Compound offered no protection against the Borers.

Paper Wrappers, Wooden Tree Veneers, etc.

Although these were not tested out at Berryville, it might be well to give a few notes regarding their use. In 1911, Hayhurst observed an instance of where a beetle in eating its way out of its pupal cell had eaten right through a tarred felt wrapper which was over the place where it emerged from the tree.

It has been the author's observation that various paper wrappers are inefficient, either because they rot or else because of the fact that they are torn and made useless by termites or ants.

It was further observed in the old orchard at Berryville that trees wrapped with newspapers, as a protection against rabbits, almost invariably harbored under these wrappers a colony of ants. These ants were observed attending a species of pseudococcus, and it is not unlikely that they would establish symbiotic relationship with the Woolly Aphis.

Wrappers also tend to keep the trunks of the trees cool and moist, and it was observed that the conditions thus established were especially conducive to attacks of *Synanthedon pyri*, which insect is quite common in the Ozarks. At any rate, Synanthedon seemed to thrive especially well under the paper wrappers. The same objections would perhaps be found with wooden tree veneers. Moreover, if our screening tests would be indicative, this veneer would have to be altered each year to allow for growth of the trees, which would add to the cost of their use as protectors.

Conclusions: 1. Paper wrappers and tree veneers may be dangerous on account of harboring other insect pests.

2. The retreatment and readjustment each year would perhaps make the cost out of the question.

Screening

The use of 12-mesh screening is so costly that it would have to be very efficient and permanent to begin with, before it could be

given much consideration as a borer protector. For the screening only, the cost would range from one cent for a two-year-old tree, to about six or seven cents for a 12-year-old tree.

In these tests, screening was so applied that it would stand out all around the tree. A few strands of the wire were pulled out along one edge and the free ends were then passed through the other edge of the screening and bent over, thus securely locking the protector around the tree. The screening was then crimped around the top and securely fastened to prevent adults from entering.

At the end of the first year it was noticed that the screens were rusted out below the surface of the ground. Were it not for this, it would seem that screening would last at least three years. It was found, moreover, that the screening had to be readjusted each year. Another objection against screening was the fact that a tendency to girdle the trees readily developed when screens were tightly fastened around the top.

Examination of 133 screened trees showed that only two were infested in 1915, thus representing a control of 85.9 per cent. In the second year, 15 were infested and the control was only about 51.3 per cent. In the case of the infested trees, it seemed that beetles must have deposited through the meshes at a point where the screening happened to touch the trunk of the tree. Other cases, trees were infested when there was no means of accounting for how the beetle could have deposited its egg in the tree.

Conclusions: 1. That the cost of screening makes it prohibitive as a protector.

2. The danger from girdling is another factor against its use.

Asphaltum

After investigation, it was thought that asphaltum might hold some promise as a borer protection, provided that it did not injure the trees and it was sufficiently permanent not to require much retouching. It was found that two pounds of asphalt were required to cover a twelve-year-old tree, and that one pound would cover about 10 two-year-old trees.

In 1912, some preliminary tests were made on twelve-year-old trees. Results indicated that where the asphalt covered the bark it caused a tendency for excessive deposits of cork to form. The trouble did not appear to be due to the heat of application, because in this case the living tissue would have been killed in places. It was thought that trouble might have been augmented at least by heat which might have been absorbed on account of the black color of the asphalt. This seemed improbable because the injury was no worse on the south,

east or west sides than on the north. From the fact that the bark appeared normal where the asphalt cracked or chipped off, it seemed most likely that the presence of asphalt impaired the process of respiration.

Preliminary tests were made with two-year-old apple trees to see what effect treatment would have. Twenty-four trees were treated at temperatures ranging from 235 to 175 degrees C. The trees were submitted to Professor Hewitt, Plant Pathologist, whose report follows: "The asphaltum tests indicated that trees would stand asphaltum as hot as 203° C. without apparent injury, provided it was quickly applied, though a tree treated from 140 to 150 degrees C. was injured, when the application was prolonged to one-half minute. It thus appears that young trees could stand a high temperature for a short time better than a somewhat lower temperature unduly prolonged."

After the preliminary tests, it was decided to try asphaltum in the tests at the three different temperatures. One at the lowest temperature at which the raw asphalt would spread efficiently (about 150° C.); another at 130° C.; and a third at 115° C. The melting points in the latter two instances were reduced with oils. In order to determine whether it would be desirable to have the oil dry out rapidly, or to have it remain in combination longer, gasoline, kerosene and linseed oil were used. Thus, asphalt was used in seven combinations.

1. Asphalt applied at about 150° C.
2. Asphalt with melting point reduced to 130° C. with gasoline.
3. Asphalt with melting point reduced to 130° C. with kerosene.
4. Asphalt with melting point reduced to 130° C. with raw linseed oil.
5. Asphalt with melting point reduced to 115° C. with gasoline.
6. Asphalt with melting point reduced to 115° C. with kerosene.
7. Asphalt with melting point reduced to 115° C. with raw linseed oil.

As before indicated, in order to see whether some varieties might be more susceptible than others, tests were carried out with three varieties which were considered as fairly representing tough, medium and tender barks. Mammoth Black, Jonathan, and Yellow Transparent were selected.

Our conclusions in regard to asphaltum were:

1. Asphaltum will not make an absolutely borer proof coat, because of its tendency to crack, due, presumably, to the pressure of growing bark in cool weather when the coat is brittle. Exceptions should be noted here in the case of linseed oil mixtures, which remain more plastic.

2. Moisture tends to make asphalt brittle, causing it to flake off.

3. Buds in growing, readily push through the asphalt coat, thereby making it defective.

4. Cracking of asphalt coat is worse with older than with the younger trees.

5. Woolly Aphis was encountered in a number of instances, established beneath the asphalt coat where the tree has apparently shrunken from it.

6. It is the opinion of Professor Hewitt that asphalt injury will, in some instances, be conducive to the entrance of crown gall.

7. Injury to trees was frequent and occurred to such an extent as to warrant discouraging its use altogether as a borer protector. The average for all asphalt treated trees was 22.9 per cent injury, though it ranged as high as 40 per cent, depending on variety of tree and treatment.

8. Injury seemed to vary directly as the heat of application. Raw asphalt caused 26.6 per cent injury. The 130° averaged 22.7 per cent injury and the 115° mixtures averaged 7.9 per cent injury.

9. Our data suggested that the kerosene asphaltum mixtures might cause a little more injury than the other oil mixtures, though this is by no means conclusive.

10. Injury varied with the variety. For all asphalt treated trees it was 15.1 per cent, 21.5 per cent and 25.2 per cent, respectively, for Mammoth Black, Jonathan, and Yellow Transparent.

11. Injury was of two types. (a) One type due, apparently, to scalding of the bark as a result of the heat of application. It was characterized by killing of the bark, usually along one side, which frequently induced a malformed, gally condition, due, presumably, to the attempted healing over of killed bark by the surrounding growing tissue. (b) A second type of injury appeared to have been induced by interference with the normal process of respiration. It was characterized by greatly enlarged lenticels, frequently accompanied by excessive deposits of cork.

12. Injury in the young trees was less the second year than the first, which indicated that it was due mostly to the heat of application.

13. Injury of the second year was confined to a corky type, due to impairing of the process of respiration.

14. The older trees appeared not to have been injured by scalding, but seemed to be injured by the impairment of the process of respiration, as indicated by immense deposits of cork.

15. As a protection against borers, asphalt gave protection of 82.1 per cent the first year for all trees.

16. The asphaltum combinations with oil apparently give a little better protection than the raw asphalt, due, presumably, to the fact that the oil mixtures were more plastic and permitted the growth of the trees without cracking the asphalt coat. Raw asphalt averaged

a protection of 69.1 per cent, but all the oil mixtures averaged 85.9 per cent.

17. Though the trees were retouched, treatment was less effective the second year than the first, the average protection the second year being 7.7 per cent as against 82.1 per cent for the first.

18. Up to a certain age, it appeared that asphalt varies in efficiency inversely as the age of the tree. In other words, the older the trees the less efficient the treatment.

As a result of our investigations at Berryville, we concluded that the most practical manner of handling the borer properly is by worming the tree at the right time every year.

Summary

1. That the protection offered by white lead is not commensurate with returns.
2. That pruning compound is worthless as a borer protector.
3. That paper wrappers and wooden veneers, from first observations, appear to be impracticable.
4. That the cost of screening is too great to warrant its use as a borer protector.
5. That the use of asphaltum is attended with injury and that its efficiency as a borer protection is not worthy of the risk to the trees.
6. That worming the trees during the months of August and in early September is the most practicable as well as the cheapest method for the controlling of the borer.

Vice-President G. A. Dean: If there is no discussion, we will now listen to a paper by Mr. George H. Lamson, Jr.

MERCURIAL OINTMENT, AN EFFECTIVE CONTROL OF HEN LICE

By G. H. Lamson, Jr., *Storrs, Conn.*,

Insecticides, such as the arsenate of lead, lime sulphur, hellebore, hydrocyanic acid gas, carbon bisulphide and nicotine solutions, are of known value and it is from these that the economic entomologist usually draws for the direct control of insects.

To most of you the problems of the control of insects affecting the products of the orchard, field, forest and garden are of most interest, though from time to time your attention is directed to those animal parasites that are of much economic importance.

Those attempting the control of lice on poultry have become impressed with the difficulty attending this operation for the reason that these small active forms increase in such numbers as to make many types of control impracticable or only partially efficient.

For a long time powders and dust baths have been recommended to those who would free their poultry from lice but it is the ineffectiveness of this method that I would like to emphasize at this time.

To determine the relative value of various means of control, one hundred and fifty well grown white leghorn pullets and male birds were used in the tests made a year ago last summer. This stock was badly infested with lice and they were placed in separate coops and runs so that they would keep under control and at the same time have sufficient exercise. Pyrethrum, the Lawry or Cornell, powder, lard, vaseline, mercurial ointment normal strength, and mercurial ointment dilutes one to two parts, one to three parts, one to five parts, one to ten parts, were tried, together with the usual check lot, each lot consisting of from ten to twelve birds.

The results from these tests were very marked, showing distinctly the inefficiency of the dusting methods even when the operation was repeated several times, for the test extended over the whole summer. The vaseline and lard were more effective over a longer period than the powders. Of the powders, the Cornell (Lawry) powder made up of two and one-half pounds of plaster of paris, one-fourth pint of crude carbolic acid and three-fourths pint of gasoline, caused the death of many lice soon after the powder was applied. As a demonstration of this, these lice were shaken on a large clean piece of paper. This result seemed a positive evidence of effectiveness, but on examining the birds so dusted a few days afterward the numbers of lice seemed to have been but slightly diminished, making continued applications necessary, yet never quite freeing the hens of the lice.

The fact that a hen dusted with a powder shakes much of that powder out of her feathers soon after the mixture has been applied, accounts for a loss of some of the effectiveness of this method. Most dusts, too, lose their effectiveness long before the next generation of lice is hatched. The dust baths are likely to become non-effective by being covered with feathers and accumulated excrements, making them damp and hard.

The use of the mercurial ointment did not cause the death of the lice so quickly, but within a few days no lice could be found upon the hens and this condition lasted over a period of from eight to sixteen weeks. The mercurial ointment caused some burns but the dilution of one part mercurial ointment to two parts vaseline controlled the lice and caused only a few slight irritations that lasted but a short

time. The more dilute mercurial preparations lost their effectiveness as the amount of mercury was diminished.

After this one hundred and four chickens were treated in the laboratory where they could be under close observation. Here tests were made with these preparations, particularly the mercurial ointments of various strength. The ointment was applied to different parts of the body such as on the head, under the wings and under the anus. The application of the mercurial ointment diluted to the strength of one part to two parts of vaseline was most effective for the largest number of birds when applied under the anus or vent. This was probably due to the fact that the two species of body lice that were more numerous upon birds studied laid their eggs in this region. The application was nearly as effective when placed under the wings and least effective when placed only on the back of the head and neck though for the hens affected with the head and body lice it would give the best results to apply to this region as well as under the anus.

The method of application was to take an amount about the size of a pea and rub it into the base of the feathers. This adheres to the finer portion of the hen's covering and remains there for a long time. A hen thus treated was kept in a glass case for a time under observation; many dead lice were found on the floor of the case while but three live lice were seen to leave her.

Some little confusion occurs in the use of the term mercurial ointment and blue ointment. Mercurial ointment contains 50 per cent of metallic mercury with 50 per cent petrolatum (vaseline).

Blue ointment is a mixture consisting of 67 per cent mercurial ointment and 33 per cent vaseline, and, therefore, contains about 33 per cent of mercury.

Mercurial ointment costs $1.75 per pound while blue ointment costs $1.50 per pound. It is, therefore, cheaper to buy the mercurial ointment and dilute it with vaseline, using one part of the former to two of the latter. To mix this it is best to place the ingredients on a pane of glass and work them together with a case knife, being sure that the mixing is thoroughly done. Place in a receptacle and label. An ounce of this ointment is sufficient to treat from sixty to seventy hens while the application can be made almost as fast as the hens can be caught. In that much time is likely to be spent in catching the fowl, it is best to do this work after the birds have gone to roost. The cost involved to buy and apply this ointment is less than one-half cent for each hen. To be sure this should not be used for the setting hens on account of the effect it might have upon the respiration of the chick embryo, but if applied one or two months before, the hens will not be

lousy at the incubating period. For the young chickens a little sweet oil is a practical control measure owing to the tenderness of the skin.

Mercurial ointment is by no means a new insecticide as it has been used for years in the control of Pediculidæ. It has been used also in Denmark and other European countries on cows for cattle lice. Its value as an insecticide for hen lice has as yet not been widely known, yet those who have given this a trial have become enthusiastic over the results obtained and consider it a specific.

It seems hardly possible that a small amount of mercurial ointment applied to a restricted region of a hen's body will free it from lice but the results are above expectation.

Vice-President G. A. Dean: The paper is now open for discussion.

Mr. D. M. Rogers: May I ask how frequently the lice must be treated?

Mr. G. H. Lamson, Jr.: We determined that the application in the summer would last two or three months. When applied in the fall or winter, it would last four or five months, so I believe in the North that three applications would keep hens free from lice throughout the year. Probably in the South it would take four or five more.

Mr. Z. P. Metcalf: In North Carolina, six applications a year are necessary to keep the hen louse in control. The head louse seems to require more than six applications a year as it is not as easily controlled as the hen louse.

Vice-President G. A. Dean: We will now pass to the next paper by Mr. Z. P. Metcalf.

LIME AS AN INSECTICIDE[1]

Z. P. Metcalf

In 1912 Mr. C. B. Williams, chief of the Division of Agronomy of our station called my attention to the ravages of the common and four-spotted cow-pea weevils (*Bruchus chinensis* Linn. and *B. quadrimaculatus* Fabr.) in the cow peas that were being saved for seed by the station. I at once suggested to him that we fumigate them with carbon bisulphide, which was done, using four pounds to 1,000 cubit feet of air space in a very tight bin at 74° F. for 72 hours. Contrary to our expectations, however, the cow pea weevils continued to breed in undiminished numbers, although a great many adults were killed at the time the fumigating was done

[1] Contributions from the Department of Zoölogy and Entomology of the North Carolina College of Agriculture and Experiment Station, No. 7.

I think that this was due to the fact that all stages of these weevils are to be found in the peas at one and the same time, and while this strength of carbon bisulphide is ample to kill the adults that have emerged from the cow peas it does not have any effect on the stages in the pea nor on the eggs which are glued to the outside of the pea. Hence the following year we went a little farther afield and tried, not only the carbon bisulphide at fifteen and thirty pounds per 1,000 cubic feet of air space, but also tried mixing peas with kerosene at the rate of one-half and one pint per bushel, crude carbolic acid at the same strengths, and air slaked lime at the rate of one part to four parts of peas and at the rate of one part to eight parts of peas. These peas were treated late in September, 1913, and left until the following spring when it was found upon examination that the peas treated with air slaked lime one to four gave a germination of 71 per cent, the peas treated with air slaked lime one to eight a germination of 48 per cent; whereas, the peas treated with carbolic acid gave only 21 per cent, those with kerosene 21.5 per cent, and those with carbon bisulphide 17.5 per cent. This led us to believe that air slaked lime was perhaps the most effective remedy that we could use against the cow-pea weevils.

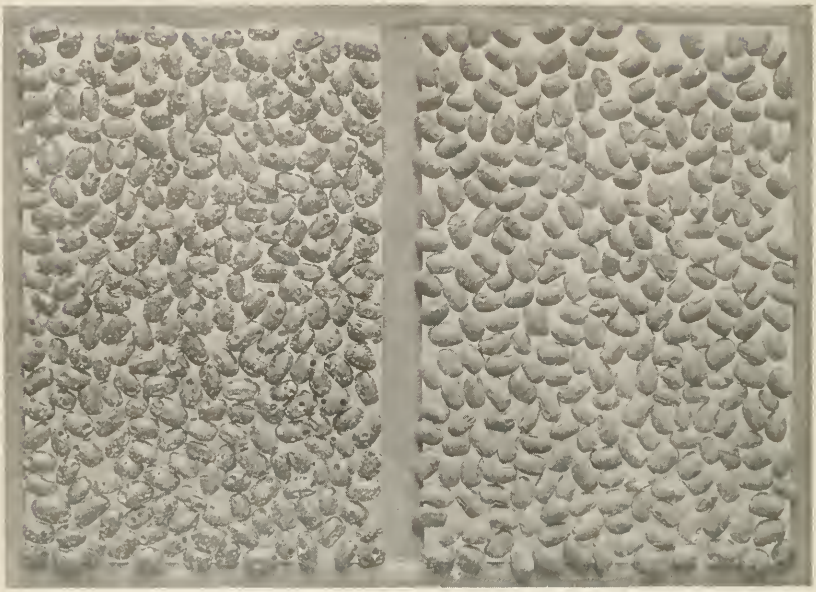
In December, 1915, we planned a somewhat more elaborate experiment in which peas were treated with varying proportions of air slaked lime ranging from four parts lime to one part peas to one part lime to eleven parts peas. These peas were moderately infested at the time they were treated, the variety called general crop in the table being the worst in this respect. Unfortunately, no germination tests were made at that time; neither were there any tests made at the usual planting time,—two critical points that were overlooked. However, treated peas were stored in ordinary sacks in the seed room and tied to each sack was a liberal sample of untreated peas which served as a check. These peas were examined this past fall, and two checks were taken upon the effectiveness of the various strengths of lime tried.

One check consisted of counting 1,000 each of the treated and check peas and then counting the number of adult emergence holes per pea. The number of adults emerging from a single pea ranged from none to twelve with a mean of 1.04 for the treated peas and a mean of 3.4 for the untreated. However, the mean of the four greatest strengths tried was .027 for the treated peas and 3.52 for the untreated peas. This is, perhaps, not altogether a fair test of the effectiveness of a remedy, for it is rather hard to believe that the lime could have any effect on the adults ready to emerge. On the other hand, larvæ that are able to pupate and then die have caused as much damage to the peas as have larvæ which pass through their transformations and

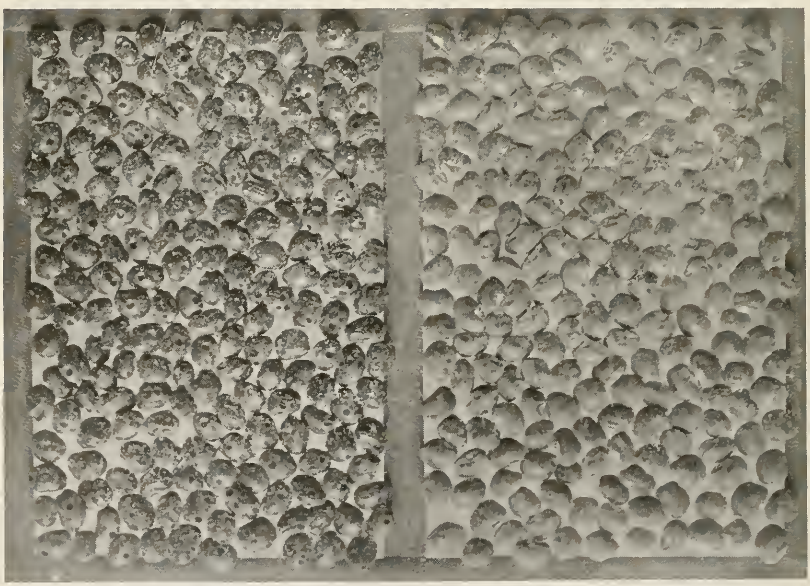
emerge as adults. So that it is possible for a pea to be completely riddled by the larvæ, yet none of them be able to get sufficient food to be able to complete their transformations; whereas, another pea may show some emergence holes and still be able to germinate a good strong plant. But in the long run I do not believe that this will hold and, with the large numbers counted, I believe that the number of emergence holes is indicative of the effectiveness of the remedy, although the exceptions noted above will have to be borne in mind. I believe that the exceptions noted in the table may be accounted for in this way. Take, for instance, the variety clay which was treated with lime one to eight parts of peas. It will be noted that more adults emerged from the treated peas than from the untreated and yet the treated peas germinated 22.5 per cent, whereas, the check germinated only 6 per cent. Now this may be accounted for in this way, adults in large numbers were ready, or almost ready, to emerge when the treatment was given. However, the amount of lime used was sufficient to prevent their laying eggs or prevented the larvæ developing in normal numbers if the eggs did hatch. On the other hand, in the untreated lot the adults emerged and laid eggs in large numbers, these eggs hatched, but the larvæ were so crowded that they failed to complete their transformations, but they did not fail to so completely riddle the peas that only a very small percentage were able to germinate.

The other check on our results was the percentage germinating. These tests were made by the state botanist, Mr. J. L. Burgess, in the usual way for making such tests, and are the averages of two tests of 100 peas each. These peas were taken at random from the 1,000 peas that had been previously counted, and represent, it is believed, a fair sample of the various lots of peas. It will be noted from the table that, without exception, the treated peas gave a higher percentage of germination than the untreated peas, although in some cases the differences were not very marked, especially in the case of peas treated one to eleven. This test was in one way not fair, in that it was made several months after the usual time for planting peas, and the percentages are undoubtedly much lower than they would have been had the tests been made at planting time. But, on the other hand, if the figures are compared treated with check in each case it does give a comparison that is striking. It will also be noted that, relatively speaking, the greater the amount of lime the higher the germination and also the peas treated with lime two to one, one to one and one to two show nearly the same percentage, whereas, when we go below one to four the germination falls off very decidedly.

In conclusion, it seems safe to recommend to farmers to treat their

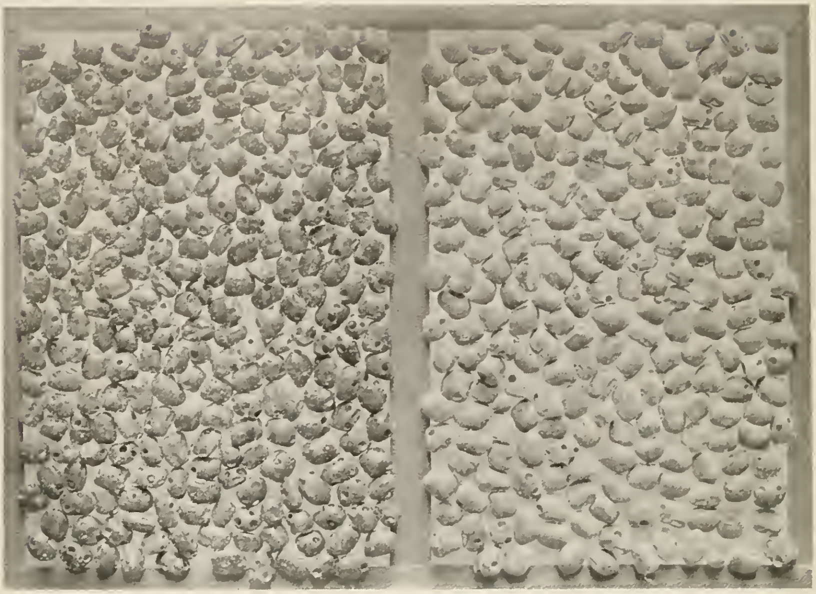


Cow peas treated with 4 parts of lime to 1 part of peas.

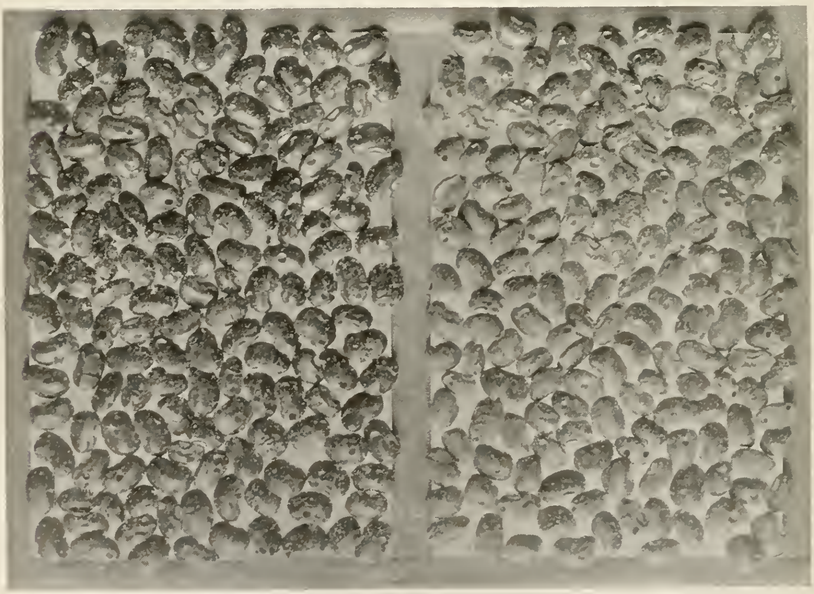


Cow peas treated with 1 part of lime to 2 parts of peas.

Treated on the right, untreated on the left, in both illustrations.



Cow peas treated with 1 part of lime to 4 parts of peas.



Cow peas treated with 1 part of lime to 11 parts of peas.
Treated peas on the right, untreated on the left, in both figures.

Lime as an Insecticide

Variety	Parts		Number of Peas in 1,000 Showing													Total Number of Adults Emerging from 1,000 Peas	Estimated Number Adults Emerging per Bushel	Percentage Peas Germinating
			0	1	2	3	4	5	6	7	8	9	10	11	12			
	Lime	Peas	Emergence Holes															
Catjang	4	1	993	7												7	1,792	71.0
Catjang	..	..	16	64	158	255	217	171	79	35	4					3,619	857,703	0.0
Red Ripper	2	1	969	28	2	1										35	5,180	53.0
Red Ripper	..	..		6	17	119	107	206	172	213	91	49	14	4	2	5,755	817,210	0.0
New Era	1	1	977	22	1											24	4,656	45.5
New Era	..	..	12	137	321	369	102	48	10	1						2,601	498,190	.5
Whippoorwill	1	2	960	39	1											41	4,838	53.5
Whippoorwill	..	..	104	186	356	249	65	29	7	3	1					2,121	254,520	1.5
General Crop	1	4	457	322	134	56	22	8	1							892	196,240	19.5
General Crop	..	..	21	93	170	217	165	164	83	50	22	11	3	0	1	3,129	745,800	3.0
Brabham	1	4	623	124	133	64	33	19	3	1						834	116,760	28.0
Brabham	..	..	8	69	206	338	234	114	22	7	2					3,198	291,018	0.0
Two Crop Clay	1	5	800	98	58	32	10	2								360	52,200	28.0
Two Crop Clay	..	..	3	38	134	240	188	240	98	44	14	1				4,195	608,275	0.0
Taylor	1	6	184	136	173	201	103	110	46	31	7	6	2	1		2,681	313,627	26.5
Taylor	..	..	7	103	160	262	135	160	77	60	20	8	5	3		3,846	365,560	.5
Black	1	7	343	333	163	85	33	34	7	1	1					1,273	142,576	18.5
Black	..	..	5	31	147	263	197	189	95	62	7	4				3,943	524,419	0.0
Clay	1	8	57	80	196	266	132	126	96	37	8	2				3,345	521,820	22.5
Clay	..	..	24	76	317	137	131	42	26	9	1					3,237	504,972	6.0
Groit	1	9	570	249	125	40	11	5								688	99,760	21.0
Groit	..	..	230	300	323	112	31	4								1,416	201,072	7.5
Wonderful	1	10	147	161	284	227	79	74	18	8	1	1				2,277	266,400	20.5
Wonderful	..	..	3	44	102	183	173	132	108	132	39	22	9	3		4,604	543,272	0.5
Black Unknown	1	11	464	212	134	110	45	27	5	3						1,176	164,640	6.5
Black Unknown	..	..	77	220	268	225	90	52	28	23	11	4	2			2,524	315,500	3 5

peas by storing them in air slaked lime at the rate of one part lime to two parts peas by weight; at least, until something more effective and something cheaper and simpler can be devised for the average farmer.

Vice-President G. A. Dean: Is there any discussion?

Mr. G. W. Herrick: Just how were the peas treated? Was the lime put on and simply shoveled over and over?

Mr. Z. P. Metcalf: We simply took air slaked lime and poured over the peas and then we put them back into the sacks, no attempt being made to mix the lime thoroughly with the peas.

Mr. G. W. Herrick: Did you moisten the peas?

Mr. Z. P. Metcalf: No.

Mr. R. A. Cooley: How soon after harvesting were the peas treated?

Mr. Z. P. Metcalf: In this case they were treated in December. Better results would have been secured if they had been treated in September directly after harvesting.

Mr. W. E. Hinds: I am very much interested in this matter because it is of great importance, especially to the Gulf States. One point in connection with the treatment by carbon disulphide that interested me particularly was the serious injury to germination that resulted. I have heard from other sources of serious injury to peas from carbon disulphide treatment and would like to mention one series of experiments made at Auburn, Alabama, last year. Several varieties of cow peas were submerged in liquid carbon disulphide for periods ranging from approximately a minute to a thousand hours with absolutely perfect germination in all cases. The tests that we have made show that these differences are due to the varying percentage of moisture in the seeds at the time of treatment. Dry seeds were uninjured.

Mr. Z. P. Metcalf: I did not intend to state that peas treated were injured by the carbon disulphide. They were injured by the weevils. The weevils kept right on laying eggs after we treated them. We had to make continuous applications. I do not think that there was any injury by carbon disulphide.

Vice-President G. A. Dean: The next paper on the program will be read by Mr. W. C. O'Kane.

SOME FACTS ABOUT CARBON DISULPHIDE

By W. C. O'Kane, *Durham, N. H.*

(Withdrawn for publication elsewhere.)

Vice-President G. A. Dean: Is there any discussion of this paper?

Mr. H. T. Fernald: Professor O'Kane has dwelt on the side of the question dealing with the efficiency of the treatment against the insects. Has he any observations to give us as to whether this treatment had any effect on the plants involved?

Mr. W. C. O'Kane: We have a lot of information, but I do not have the data with me.

Mr. H. T. Fernald: Several years ago we made tests of the carbon disulphide method of controlling onion maggot by placing the material in the soil near the young onion plants. We found it possible to kill the maggots, in many cases. Taking our results in a general way they corroborate those of Professor O'Kane as to killing them all, but many of the treated plants were injured.

Vice-President G. A. Dean: Mr. E. R. Sasscer will present the next paper on the program.

RECENT VACUUM FUMIGATION RESULTS

By E. R. Sasscer, *Bureau of Entomology, Washington, D. C.*

(Withdrawn for publication elsewhere)

Vice-President G. A. Dean: Are there any remarks?

Mr. R. A. Cooley: I would like to ask what provision has been made for exhausting the gas from the large cylinders.

Mr. E. R. Sasscer: The exhaust gas is passed through a solution of sodium hydroxide. One firm passes it through a reclaiming hydroxide and uses it twice. Another simply allows it to pass through and lets it escape into the air through the roof.

Vice-President G. A. Dean: We will now listen to a paper by Mr. P. J. Parrott.

THE RADISH MAGGOT AND SCREENING

By P. J. Parrott, *Geneva, N. Y.*

In western New York root maggots are very destructive to radishes, and in clay soils, especially, this vegetable can no longer be grown with any assurance that the plants will be free from injury. As screening of beds has proven satisfactory for the production of seedlings of late cabbage, experiments have been carried on by the New York Agricultural Experiment Station for the past three years to ascertain the effects of growing radishes under cheesecloth on the quality and growth of the roots.

In brief, the methods of conducting the tests are as follows:—Commencing with the latter part of March the radish seed is sown by means of a garden drill in beds at intervals of one week until about the middle of May. As soon as planting is completed, the frames, consisting of 12-inch boards, are placed in position when the cheesecloth is attached. With the appearance of the first pair of true leaves the plants were thinned and weeded; and when of desirable size they were pulled and weighed.

The weights of plants grown in screened frames and in open beds for the years 1914–16 are given in Table I.

Table 1, Showing Weights of Radishes in Screened and Open Beds

(Counts and weighings are based on rows of 100 feet in length.)

Screened				Not screened	
Year	No. of Plat	No. of Plants	Weight	No. of Plants	Weight
1914	1	506	9 lbs. 9 ozs.	496	4 lbs. 0 ozs.
	2	332	6 " 14 "	240	1 " 14 "
	3	324	6 " 4 "	245	2 " 8 "
	4	347	9 " 3 "	230	2 " 9 "
	5	518	8 " 6 "	532	5 " 9 "
	6	518	9 " 12 "	478	5 " 1 "
1915	1	710	11 " 6 "	323	2 " 11 "
	2	1092	12 " 4 "	432	2 " 12 "
	3	1000	16 " 12 "	680	7 " 4 "
	4	1004	12 " 4 "	665	7 " 4 "
	5	1007	9 " 12 "	520	2 " 8 "
1916	1	768	10 " 0 "	725	5 " 3 "
	2	852	9 " 9 "	896	6 " 1 "
	3	917	10 " 12 "	885	3 " 8 "
	4	652	7 " 5 "	685	1 " 13 "
	5	493	6 " 11 "	420	3 " 1 "
	6	696	9 " 4 "	423	3 " 4 "
	7	748	9 " 5 "	447	3 " 5 "
	8	812	9 " 8 "	416	3 " 5 "
Average per 100 feet for 1914.		424.16	8.3 lbs.	370.16	3.59 lbs.
Average per 100 feet for 1915.		962.6	12.47 "	524	4.48 "
Average per 100 feet for 1916.		742.25	9.04 "	612.12	3.68 "

An examination of the foregoing table shows that in most of the plats in the screened frames there was a larger stand of plants as compared with the uncovered beds, and data at hand also indicated that there was a correspondingly larger number of marketable roots. As demonstrated in our experiments with cabbage seedlings, these differences are due to several factors. First of all cheesecloth, if properly attached, affords complete protection from root maggots and, according to the fineness of the mesh, reduces to a more or less extent in-

juries by the flea-beetle. Both pests, when abundant, may destroy seedlings as well as retard growth. Moreover, there exist in the screened frames superior conditions for the growth of the plants. A larger percentage of the radishes establish themselves since there is less evaporation of moisture and no baking of the soil to check their development. Incrustation of clay soil, accompanied with hot weather and slight precipitation, affords conditions that are exceedingly uncongenial to the radish and as fatal as the insect enemies to the production of roots that are mild, succulent and tender.

Adjournment.

Morning Session, Friday, December 29, 1916, 9.45 a. m.

Vice-President G. A. Dean: The first paper on the program will be read by Mr. Marcovitch.

THE STRAWBERRY WEEVIL IN MINNESOTA

By Simon Marcovitch, *St. Paul, Minn.*

(Withdrawn for publication elsewhere.)

Vice-President G. A. Dean: As Doctor Hewitt has now arrived, we will next listen to the annual address of the President.

INSECT BEHAVIOUR AS A FACTOR IN APPLIED ENTOMOLOGY

By C. Gordon Hewitt, D.Sc., F.R.S.C.,
Dominion Entomologist, Ottawa, Canada

In determining the choice of a subject for my address I have been guided by a feeling that, owing to the extraordinary progress that has been made in the knowledge and methods of applied entomology during recent years, the time at my disposal could not be occupied to better advantage than by an examination of what I believe to be fundamental to an adequate appreciation of the problems with which we have to deal and their successful solution.

We have accumulated an enormous mass of facts relating to insect life in all its manifold relations to the welfare of man, and many of these facts have furnished us with the means of determining methods of preventing or controlling the noxious effects of insect activity. But it would appear to me that we have reached a stage where our accumulated knowledge is rather like a city that has developed along the

paths marked out by ancient trails and where a need has arisen for the earnest consideration of a town-planning system. Our further progress must be based upon principles that modern experience has indicated as being fundamental to a rightly conceived and an orderly development of future investigation.

Insect behaviour constitutes the basis of applied entomology and, while that fact may now be more generally realized, I feel that if the point of view such a conception implies were constantly borne in mind we should be able to approach the solution of our problems in a manner that would lead to even greater success than has already crowned our efforts.

Action is the result of the manner in which man experiences. So, also, the reaction of an insect to its environment finds expression in the behaviour of the insect. Behaviour, as Jennings has stated, "is merely a collective name for the most obvious and most easily studied of the processes of the organism, and it is clear that these processes are closely connected with, and are indeed outgrowths from, the more recondite internal processes." Stated briefly in another way, behaviour consists in the adaptation of the insect to its environment. Anything injurious to the insect causes changes in its behaviour and conversely anything advantageous to it produces a change in the behaviour. Of the factors which regulate behaviour in insects, as in other organisms, internal conditions and processes are effective no less than external, and both may be, and generally are, the product of environment. Further, to be effective the external stimulus of the environment, whether it be physical or biological, must produce a change in the physiological state of the organism.

The activities of injurious insects which furnish the problems of applied entomology are more pronounced in countries where, for various reasons, the stability of the physical and biological environment is changed. This affords the reply to a question often asked, namely, why entomologists are faced with more problems in newer countries, such as our own, than in older countries? One of the chief causes affecting the stability of the environment and consequently the activities of the insects in such countries as the United States and Canada is the extension and development of agriculture and of agricultural areas. In countries of an older civilization the environmental conditions, particularly the agricultural conditions, are fairly stable by reason of the long period of their gradual development. In such countries we find a conservative type of husbandry with which careful rotations of crops and a fairly intensive system of cultivation are associated. In the newer countries, not only has widespread development within comparatively brief periods of time been responsible for

extensive changes in environmental conditions, but such development, particularly in agriculture, has necessitated, among other things, the importation of large quantities of the natural products, including vegetation, from older countries with the inevitable introduction of the insects affecting those products, thereby not only modifying the environmental conditions for the native insects in the new country, but also introducing into a new environment insects from another country and from a native environment more conducive to stability in behaviour. Thus the conditions are altered for both the insects native to the new country and the insects fortuitously introduced.

Formerly, the investigations of the entomologists did not extend very far beyond a study of the life-histories of insects, and control measures were largely based on such knowledge supplemented by a limited study of the insects' habits; the idea being, as we were told, "to find the weak spot in the insect's life-history." The limitations of such methods of solving entomological problems were demonstrated by an inability either to account for the outbreaks of certain insects or to discover effective means of control. Not until the behaviour of insects, that is, their reactions to their environment, to each other and to the different biological constituents of that environment, was studied with true appreciation was it possible to make satisfactory progress in the control of certain serious pests. The corn root-aphis (*Aphis maidi-radicis*) furnishes a good example of this fact. It was not until Forbes and his assistants worked out the relation of this insect to the ant *Lasius niger americanus*, on which it depends for its well-being, that any success in controlling this serious corn pest could be attained; and such control measures as the breaking up of the ant colonies in the spring and the destruction of weeds on which the ants plant their wingless aphid captives before the growth of the corn, are based solely on a knowledge of behaviour.

The reaction of an organism to environmental influences is known as a tropic reaction or a *tropism*. The external stimulus may induce a physiological state that exhibits response in movement, or the physiological condition of the organism may be changed in a more fundamental manner with the result that not only is the organism itself affected permanently, but the progeny experience the effects of the stimulus and react by a change in behaviour or even in structure. For the sake of convenience we may term such tropic reactions as *individual* and *racial*, respectively.

It will not be possible in the time at my disposal to deal with more than the main types of tropic reactions to physical factors and a treatment of these must of necessity be brief in character. Let us, therefore, consider the chief tropisms: Chemotropism, thermotropism,

hydrotropism, phototropism, and anemotropism. If time permitted, a consideration of that extensive realm of insect behaviour included within the category of instinctive behaviour would be desirable, but we must content ourselves with the knowledge that this type of behaviour is the result of reflex responses to the various types of tropisms.

Chemotropism is the reaction to stimuli of a chemical nature perceived through the olfactory sense. Inasmuch as odour is undoubtedly the most important factor in the environment of insects the significance of this tropism is evident. The chief objects of animal or plant life, are feeding and reproduction, and in the search for food or for the sexes, or in oviposition, chemotropism plays a predominant part. The sexual chemotropism of insects, particularly among the Lepidoptera, has long been a familiar phenomenon to entomologists. But it is in their response to chemical stimuli as affecting the search for food and oviposition that we find a tropic reaction that has untold possibilities in its practical application.

The vital functions of search for food and oviposition are closely associated. The female insect deposits its eggs on substances best suited for the nourishment of the larvæ. The females of *Pieris rapæ* and *P. brassicæ* select the leaves of cruciferous plants, attracted thereto by the mustard oils, a group of glucosides present in these plants, as shown by the experiments of Verschaffelt. The same investigator showed that the larvæ of the sawfly *Priophorus padi* (L.) Thomas, which feeds on the foliage of certain rosaceous plants, are probably attracted by a glucoside, amygdaline. The chemotropic reactions on the part of carrion beetles, and to excrement on the part of coprophagus Coleoptera and Diptera, are well known. Howlett induced *Sarcophaga* to oviposit in a bottle containing scatol, a decomposition product of albuminous substances; and he stimulated the oviposition response in *Stomoxys calcitrans* by means of valerianic acid. Richardson's recent work on the oviposition response of the house-fly, in which flies were induced to oviposit in response, apparently, to an attraction of ammonia in conjunction with butyric and valerianic acids, opens up suggestive lines of investigation. Barrows finds that the positive reaction of *Drosophila* to fermenting fruit is due in a large measure to amyl, especially ethyl alcohol, acetic and lactic acid and acetic ether.

While the aforementioned cases, which might be multiplied, illustrate the chemotropic responses of insects in so far as they affect the oviposition response, that is, the search for food as affecting the future larvæ on the part of the ovipositing female, there is the large class of chemotropic reactions which affect only the adult without reference to the progeny. An illustration of this class is afforded by the investi-

gations of Howlett on the fruit-flies of the genus *Dacus* in which the males are attracted by the eugonol oils, iso- and methyl-eugonol, which are constituents of oil of citronella.

The control of outbreaks of the larvæ of Arctiid moths in India by the capture of the adult moths in bait traps of the Andres-Maire pattern is an example of the manner in which practical advantage may be taken on a large scale of a chemotropic response.

The negative chemotropic reaction of insects is illustrated in the practical use of repellent odors. *Musca domestica* is repelled by certain coal-tar products such as phenol; the protection of cattle from biting flies and of man from mosquitoes is secured by the use of repellent mixtures.

Turning now to a problem of great biological interest and practical importance, namely, the different behaviour of the same species of insect to different plants, we find that what would appear to be fundamentally a chemotropic reaction is sometimes responsible for the creation of a biologically different race of the same species. In his investigations on blueberry insects in Maine, Wood has found a form of *Rhagoletis pomonella* infesting blueberries (*Vaccinium*) and huckleberries (*Gaylusaccia baccata*) that is below normal size, and this form appears to be long-established as efforts to get the apple-bred race to oviposit on blueberry and *vice versa*, failed. The physiological influence of the host plant upon the insect feeding upon it and the creation of biologically different races which may differ sufficiently to be separated as species by the tendency of members of a single polyphagous species of insect to become adapted to a particular food plant is strongly suggested by Cameron's study of the leaf-miner *Pegomyia hyoscyami* Panz. which feeds on belladonna (*Atropa belladonna*). Within this category we should also include, I believe, the case of the Arizona wild cotton weevil (*Anthonomus grandis thurberiæ* Pierce). The production of morphological changes by a change in food plants has been observed in like manner in the case of Aphides. These chemotropic responses, for that is essentially their nature, have as important a relation to the work of the taxonomist as to that of the applied entomologist.

A subject which promises results of great practical value is the study of the resistance of plants to insect attack with a view to the production of insect-resisting varieties in crops subject to injury. Comparatively little attention has been paid to this further example of chemotropic reaction, but the development of strains or varieties completely or even partially resistant to the attacks of particular insects attacking them, would place a valuable preventive measure in our hands. This is a field for joint investigation by the entomologist and the plant-breeder.

The realization that in the ultimate control of the gipsy moth in North America, the silvicultural aspect of the problem must receive serious consideration is an indication of the importance of chemotropism in the control of this pest. The elimination of favored food plants and the substitution of unfavored species such as pine are measures largely based on the principle of food attraction, that is, of chemotropism, and should be so regarded.

Enticing and suggestive as the subject of chemotropism has been shown to be, we must pass on to the next tropic reaction, namely, thermotropism. In temperature we encounter an environmental influence which is as far-reaching as it is universal in its relation to insect behaviour, and while it is inseparably associated with other factors, especially that of moisture which we shall consider later, it is in itself sufficiently potent to determine the range of insect activity in both time and space. The relation of temperature to the distribution of insects is too well known to require demonstration by examples. Merriam's laws of temperature control, namely: (1) that "animals and plants are restricted in northward distribution by the total quantity of heat during the season of growth and reproduction," and (2) that "animals and plants are restricted in southward distribution by the mean temperature of a brief period during the hottest part of the year," in general, hold true in regard to insect distribution. The importance of determining the optimum temperatures for the reproduction and development of different insects has been realized by a number of investigators, although their conclusions have sometimes been defective through neglect to take into consideration the coöperative effect of other environmental factors such as humidity. The influence of temperature on development is illustrated very strikingly in the Aphides. For example, Ewing has recently found that a constant temperature of 90° F. is sufficient to prevent completely the development of *Aphis avenæ* and that the optimum temperature for the production of wingless agamic forms of this species is about 65° F., these forms only being produced at a mean average daily temperature of about 65° F.

Practical use is now made of our knowledge of the temperature relations of insects in the employment of high temperatures as a means of insect control, and "superheating" offers great possibilities.

An interesting case of the use of temperature as a means of control is afforded by the employment of the method of close-packing of horse-manure for the purpose of preventing the breeding of *Musca domestica.* About ten years ago I found that a temperature of about 105° F. was fatal to the larvæ of *M. domestica* and in an account given before this Association in 1913 of further studies of the effects of the temperature

of the manure pile on the larvæ I showed that the larval habitat in the well packed pile was peripheral, and that excessive internal heat became practically a larvicide. Recently, Copeman has shown that practical use can be made of this principle and that close-packing of the manure is all that is necessary to prevent the breeding of flies. In a recent letter to me Copeman states that this method of control is being taken up by the military authorities on an extensive scale both in England and abroad.

Just as high temperatures are effective in insect control so also low temperatures have a like value, as is now well known. And the utilization of low temperatures in applied entomology offers a fruitful field for further investigation. Further, in northern countries exact knowledge concerning the relation of low winter temperatures, associated as a rule with degrees of humidity, to the distribution of insects is highly desirable.

The activities of all insects are so closely related to temperature that no study of their behaviour can be made without full consideration of its effects.

Closely linked with thermotropic reactions are the effects of hydrotropism, and particularly humidity. This is especially the case in the effects of climate on insect distribution and migration. The theory advanced by Ellsworth Huntingdon in his "Civilization and Climate," that as climates change nations either change with them or migrate when the change is unfavorable to more suitable climatic environment, is equally applicable to insect life. We must ever take into account the effect of the climatic stimulus on insect behaviour.

In a recent suggestive paper Pierce has called attention to the fact that "a careful study of the records of any species, charting for the time required for each activity and the temperature and then similarly for the humidity, will disclose temperature and humidity points of maximum efficiency. With the boll weevil these points lie approximately near 83 degrees F. and 65 per cent of relative humidity." This author has also pointed out the practical applications of a knowledge of the relation of climatic conditions to the control not only of the cotton boll weevil, but also to such pests as the cattle tick and the fall army-worm. Other cases are numerous.

We have always to bear in mind that a tropism may include reactions to a stimulus existing in very diverse forms. This fact is well demonstrated in the case of hydrotropism. The negative hydrotropism of the salt-marsh mosquitoes of New Jersey and San Francisco is a reaction to water *en masse,* as is the positive hydrotropism of aquatic Coleoptera and Hemiptera. On the other hand, the reaction of insects to humidity is a hydrotropism that may be brought about

by diffused moisture in the air. Similarly, moisture in the soil affects the behaviour of insects considerably, as Wheeler has shown in the case of many species of ants, and as Parker has demonstrated in his study of the sugar-beet root-louse (*Pemphigus betæ* Doane) in which it was found that soil moisture is a very important factor in controlling the rate of increase in colonies of this insect. The attraction of the so-called "watershoots" of trees such as apple for aphides should be regarded as being in effect a hydrotropism.

The importance of moisture as a factor in insect behaviour is strikingly illustrated in the case of some of our most important grain insects. Forbes has discussed the effect of drought and rainfall upon the abundance and suppression of the chinch bug in Illinois. In Canada we find that the prevalence of the western wheat-stem sawfly is governed by humidity. A lack of precipitation causes a dearth of flowering stems among the grasses in which this insect normally breeds, resulting in a decrease, the abundance of the insect depending primarily upon the prevalence of suitable grass stems. Similarly, a lack of moisture is an important natural check on the Hessian Fly, a dry season being generally recognized as prejudicial to the fly. In Manitoba, Criddle finds that the partial second brood is frequently destroyed completely by the premature ripening of the grain due to the hot weather conditions in late July. Further instances might be given of the effect of moisture on other classes of insects but sufficient has been said to indicate the diversity of the hydrotropic type of behaviour.

Reaction to light plays a prominent part in insect behaviour and numerous are the examples that might be given, were it necessary, of phototropism in insects. But while entomologists are familiar with the manner in which adult insects such as Lepidoptera are attracted to light and with the negative phototropism of many larval forms, and of adult insects such as *Anopheles*, we are still far from anything approaching a working knowledge of this reaction. Such knowledge will undoubtedly place a valuable weapon in the hand of the applied entomologist. In some cases we are able already to take advantage of this type of behaviour. Swaine finds that the destruction of piled logs by the wood-boring larvæ of the sun-loving *Monohammus* can be prevented by forming a dense shade over the logs by means of brush. In his study of the army cutworm (*Euxoa auxiliaris*) in Alberta, Strickland found that the larvæ are negatively phototropic and hide beneath the soil till about four or five o'clock in the afternoon when they come to the surface and feed. With the weaker light they become positively phototropic and a general migration in a westerly direction takes place. When food is scarce hunger may overcome their aversion to sunshine with the result that the larvæ come above ground, but they still display

a modified negative phototropism and migrate in a northwesterly direction. These facts are of practical value in controlling outbreaks of this insect.

The two previous tropisms, operating together, constitute perhaps the most widely operative of all environmental stimuli as affecting insect life. The daily activities of insects, their movements on the soil, on vegetation or in the air, are largely governed by them. And in referring to the dual influence of these stimuli it may be remarked that the various types of stimuli are very frequently coöperative. Years ago, when collecting Diptera by sweeping, Wheeler was impressed with the fact that there must be a regular diurnal up and down migration of insects in the low vegetation, comparable to the phenomenon exhibited by the pelagic fauna in the sea. The insects descend to the ground at night and with the return of light and heat rise until they reach the upper surface of the plants. There is little doubt that this diurnal migration is of economic importance and demands further careful study. Its dependence on the coöperative effect of several stimuli such as light, heat, and probably air currents, indicates the necessity, which should always be borne in mind in studying insect behaviour, of a careful analysis of tropic reactions.

The relation of the dispersion of insects to air currents is an aspect of insect behaviour that has had wide recognition since, and perhaps before, the locusts descended on the land of Pharaoh. Anemotropism is well exhibited in the case of the Rocky Mountain locust which moves with the wind and when the air current is feeble is headed away from the source. The brown-tail moth owes its distribution in New England and eastern Canada largely to wind-spread and the investigations of Collins and his associates have shown that the general spread of the gipsy moth in New England is most probably due to the fact that the first-stage larvæ are carried in a north and northeasterly direction by the warm prevailing winds rather than to dispersal by artificial means, as formerly believed. The practical value of knowledge of this type of behaviour is shown by the experiments of Le Prince and Zetek on the flight of Anopheles with the use of Quinby intercepting planes in Panama. Le Prince has suggested that where antimalarial work is to be undertaken in badly infested regions observations on the flight direction will indicate which of several possible production areas is the source of the particular species of mosquito it is desirable to eradicate.

If time permitted it would be profitable to discuss other types of tropisms and to show how this line of study throws light on the complicated instinctive behaviour of insects, particularly those exhibited

by the social Hymenoptera. The latter, however, is a subject in itself and has received the attention of more competent hands than mine; the studies of Wheeler in particular have thrown much light on this fascinating problem. As Wheeler has stated: "We know that the insect responds not only to external stimuli but also to certain unknown stimuli originating within the cells of the alimentary tract, reproductive organs, etc., and that the responses to these stimuli are often remarkably complex, as *e.g.*, in the elaborate feeding and nesting instincts of ants, bees and wasps. Nor does the complication of the problem end here. It is greatly increased by two further considerations, first, by our complete ignorance of the protoplasmic changes, chemical and physical, which precede or accompany these tropisms or the response to stimuli in general; and second, by the difficulty of explaining why all these responses are so marvelously adaptive. I venture to assert, nevertheless, that it is better to face these difficulties, insuperable as they appear, than to continue investigation in that spirit of anthropomorphism, which has been such a fruitful source of misinterpretation in the comparative study of habits and instincts."

Reference has already been made to the control of the corn root aphis (*Aphis maidi-radicis*) which is based on a knowledge of the instinctive behaviour of the ant *Lasius niger americanus*. The most notable example in applied entomology of the practical value of a knowledge of instinctive behaviour is seen in beekeeping. A knowledge of the behaviour of the bees enables us to mould their instincts along those lines most desirable from the point of view of our convenience and pecuniary profit.

Incomplete as this account is of the manner in which insects react to the various constituent factors of their environment, I trust that in the time at my disposal I have indicated the fundamental character of insect behavior in relation to the solution of the problems that confront us. We have reached a stage in the progress of our work that demands on the part of every investigator and entomological practitioner, whether he be working at problems as wide apart as taxonomy or quarantine administration, as thorough a knowledge as possible of the manifold nature of insect behaviour, that is, of the relations and reactions of insects to the physical and biological factors in their varied environments; for it is through such knowledge that applied entomologists will find solutions to some of the greatest problems that now occupy our attention and are certain to confront us in the future. Great as the contribution of entomological science to the advancement of civilization has been in the past, it is slight compared with promise of future achievement.

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Vice-President G. A. Dean: It has been the policy of the Association to discuss the presidential address at the session following the one when it is delivered. If there is no objection, however, we will now have the address opened for discussion.

Mr. A. D. Hopkins: I want to compliment the President on the selection of the subject of his address and his treatment of it. The various topics relate to fundamental principles, the importance of which every entomologist should realize. The failure to consider certain general principles and natural laws in connection with our investigations has led to a waste of time in the investigation of unnecessary details and to the recommendations of methods of preventing and controlling insect attack which has led to the waste of money in unnecessary work.

We should have a better knowledge of the fundamentals and some of us should be devoting our time to the investigation of principles and laws and make the results available to those who are engaged in the investigations of the details. We cannot all investigate these broader problems but some of the older men with broad experience should do so, and they will need the sympathy and support of the other investigators when ideas and conclusions are advanced which are new or radically different from what has been accepted heretofore. There may be, and usually is something in a new idea. Let us first be sure we understand them and then test them out in practice before we discard them.

It has not been possible for the President to cover the details and it is not necessary that he should in an address of this kind. In the consideration of general principles, we must think in general, not specific, terms.

With reference to the physiological influences of the host mentioned by Doctor Hewitt, we have found, in our investigations of methods of controlling depredations by bark-beetles in the natural forests of the West, that we must consider every phase of economy as well as efficiency. We have found that the mountain pine beetle (*Dendroctonus monticolæ* Hopk.) will attack and kill the mountain pine, yellow pine, lodgepole pine, and the sugar pine, but that if it becomes established in one host species, as, for example, the lodgepole pine, through continuous attack of many generations, the beetles—when they emerge—will not attack nearby trees of any of the other host species but will show a decided preference for the species in which they bred. That is, it will not go from one host to the other in sufficient numbers to be a menace, but will take many years for it to change from one host species to another. Now, where the less valuable lodgepole pine is thickly infested and the area is surrounded by the more valuable yellow pine, which it is desired to protect, we find that we only have to deal with the infestation in the yellow pine, knowing that the infestation in the lodgepole will remain there. This we have proven in many cases of actual practice. Therefore, any money

spent in trying to dispose of the infestation in the lodgepole to protect the yellow pine would be wasted. Whether or not other species of economic insects respond in a like manner to the influence of one or more of their multiple host species, I do not know, but it is probably true with many and the determination of the facts will lead to a more economic method of dealing with them.

Mr. T. J. Headlee: This address has drawn attention to a very interesting and important phase of our work. The feeling that the pioneer life-history work on our insects of large economic importance is approaching completion and that we should now look a little deeper has been growing. I heard from Doctor Shelford yesterday that the University of Illinois is erecting a large vivarium in which is to be installed apparatus for the conditioning of environmental factors in such a fashion that the effect of particular factors can be accurately measured. If this may be taken to indicate that the universities of the country have realized the value of determining the laws which govern the response of living matter to environmental factors and have set out to furnish facilities for collecting data, we have reason to hope that important discoveries bearing upon the phases of research mentioned by our President will not be long delayed. It seems to me that this address should be taken by our research membership to mean that the time has arrived when we must give more attention to the stimuli that influence life-history activities

Mr. W. M. Wheeler: I might mention one case that recently came to my notice that has an interesting bearing on Doctor Hewitt's address and also on Doctor Hopkins' remarks. I had two students working to get a medium on which they could raise banana flies, *Drosophila*, and Doctor Glaser made a medium of banana agar and another medium with agar of potato and found that flies would oviposit on the banana agar. They were evidently attracted to the banana by a chemotropic reaction to the banana. Now if the flies were brought up on banana agar, they will also oviposit on potato agar but the larvæ will not develop readily on potato agar. There is something like memory in this matter and is somewhat similar to Doctor Hopkins' *Dendroctonus monticolæ*.

Mr. A. D. Hopkins: Mr. Craighead is carrying on many experiments at our field station at East Falls Church, Va., to determine the extent to which insect species are influenced by their host species. He has found that while *Callidium antennatum* infests a number of host species, representing different genera such as *Juniperus*, *Pinus*, *Picea*, etc., individuals breeding in one host can not be forced to even oviposit on another. He has even transferred the larvæ from one host to another but without success, while such a transfer in the same host is successful.

Mr. P. J. Parrott: I do not want to let the opportunity pass without expressing my appreciation for the address which has been given. It certainly is a clear and concise statement of the influences bearing on the response of insects to various elements in their environments. The question of insect behavior is an immense field for study and I am pleased to see the President bring out some accomplishments from studies which were problems of theoretical interest when first initiated.

Mr. Ernst Gram: This has been a very interesting address and discussion. I would like to make a suggestion in regard to the terms used. It seems that the terms chemotropic, hydrotropic, etc., were taken from the botanists. It might be more consistent to apply the terms chemotaxis, hydrotaxis, etc., in the case of insects.

President C. Gordon Hewitt: I thank the members of the Association for their appreciative remarks in regard to my endeavor to place this problem before the Association. I only hope that the efforts I have made will result in stimulating us to take a new and broader view of our science. I believe the great danger of economic entomology today is that we are getting down too much to a dead level and are likely to get into a rut. If we do not avoid this a great deal of energy will be lost and we shall be subjecting ourselves to an increasing amount of criticism.

I will now call for a paper by Mr. R. A. Cooley.

THE SPINACH CARRION BEETLE

Silpha bituberosa Lec.

By R. A. Cooley, *Entomologist, Montana Experiment Station, Bozeman, Montana*

The literature of *Silpha bituberosa* is meager. The insect was described from Kansas in 1859 by John L. Leconte in his "The Coleoptera of Kansas and Eastern New Mexico" (Smithsonian Contributions to Knowledge, No. 126, page 6). In 1894, Dr. James Fletcher, in his "Report of the Entomologist and Botanist" for the year 1893, briefly discusses the species under the title "Another Vegetarian Carrion Beetle." This is a short account of the occurrence and food plants of the species together with brief notes on the life-history and is the first account of injuries by the insect that can be authenticated.

Prof. L. Bruner, reporting to Docter Riley on the "Insect injuries in Nebraska during the summer of 1892," in discussing beet insects, page 40, Bulletin 30, Old Series, Division of Entomology, states: "During my visit at Norfolk and while talking with Mr. Huxman relative to Beet Insects in general, he mentioned the fact of the injury

done by *Silpha opaca* in Germany. He said that the larva of this beetle was by all odds the most troublesome insect pest with which beet growers in that country had to deal. Hand picking was the remedy usually resorted to. He also stated that he had seen several specimens of the insect during the past summer at West Point, this State, upon sugar beets, and that he had killed them. He said that he could not be mistaken about the insect, as he had seen too many of them in Europe not to know them at sight. With this second reported presence of this insect in beet fields at this one locality it begins to appear that perhaps, after all, it is present in America."

In a letter from Prof. Myron H. Swenk, associate entomologist of the Nebraska Experiment Station, to the writer, dated November 2, 1916, we are informed that in discussing the occurrence of *Silpha bituberosa* in Nebraska with Professor Bruner, he had learned that this insect is occasionally found in that state and in beet fields and that the record of *Silpha opaca*, quoted above, probably refers to *S. bituberosa* rather than to *S. opaca*. It is also stated that the record of *S. opaca* "having been taken several times in beet fields, and in gardens where beets were growing" (Report of Nebraska State Board of Agriculture, p. 124, 1890) largely refers to *S. bituberosa*. If it were entirely certain that these records refer to *Silpha bituberosa* then we could record a somewhat earlier reference to the insect in economic literature.

In his report for 1897, Doctor Fletcher mentions this insect again and adopts as the common name "The Spanish Carrion Beetle." Doctor Fletcher states that the insect was sent to him from correspondents at Saskatoon, in Saskatchewan and from Calgary, Alberta. Doctor Horn in his "Synopsis of the Silphidæ of the United States with reference to the genera of other Countries" (Tran. Am. Ento. Soc., vol. VIII, p. 242, 1890) states that *Silpha bituberosa* "occurs from Kansas to Wyoming and Montana."

Through correspondence with official entomologists of the northwestern states, information regarding the geographical distribution of the species has been obtained. On the authority of Professors Bruner and Swenk, we have positive information of its occurrence in Nebraska and from Professor A. C. Burrill we learn that it also occurs in Idaho. From Mr. W. B. Bell, formerly of the North Dakota Experiment Station, it was learned that the insect had not been taken in North Dakota up to July, 1916. Prof. H. C. Severin, state entomologist of South Dakota, informed us that he has no record showing it to be present in his state. Prof. A. L. Melander has informed us that the insect does not occur in Washington, so far as their collections show nor had he heard of its presence in that state. Oregon likewise does not have the species, according to Professor Lovett. According to

information received from Dr. E. G. Titus, entomologist of the Utah Agricultural Experiment Station, it does not occur in Utah so far as is known. Professor Gillette informed us that he could find no record of *S. bituberosa* occurring in Colorado.

From these data it is apparent that so far as is known *Silpha bituberosa* does not occur west of the main divide of the Rocky Mountains excepting in the State of Idaho. It occurs from northern Kansas northward to Alberta and Saskatchewan. While it has not been recorded from Colorado, it is likely that it occurs sparingly in the northeastern portion of that state and likewise in the western portions of North Dakota and South Dakota.

From the records of its abundance and injuries in the North and the absence of such records for the South, it seems clear that this insect is to be looked upon as essentially a northern species. The truth of this is emphasized by the fact that the young as well as adults may sometimes be seen surprisingly early in the spring. It is quite clear that the species is a native one.

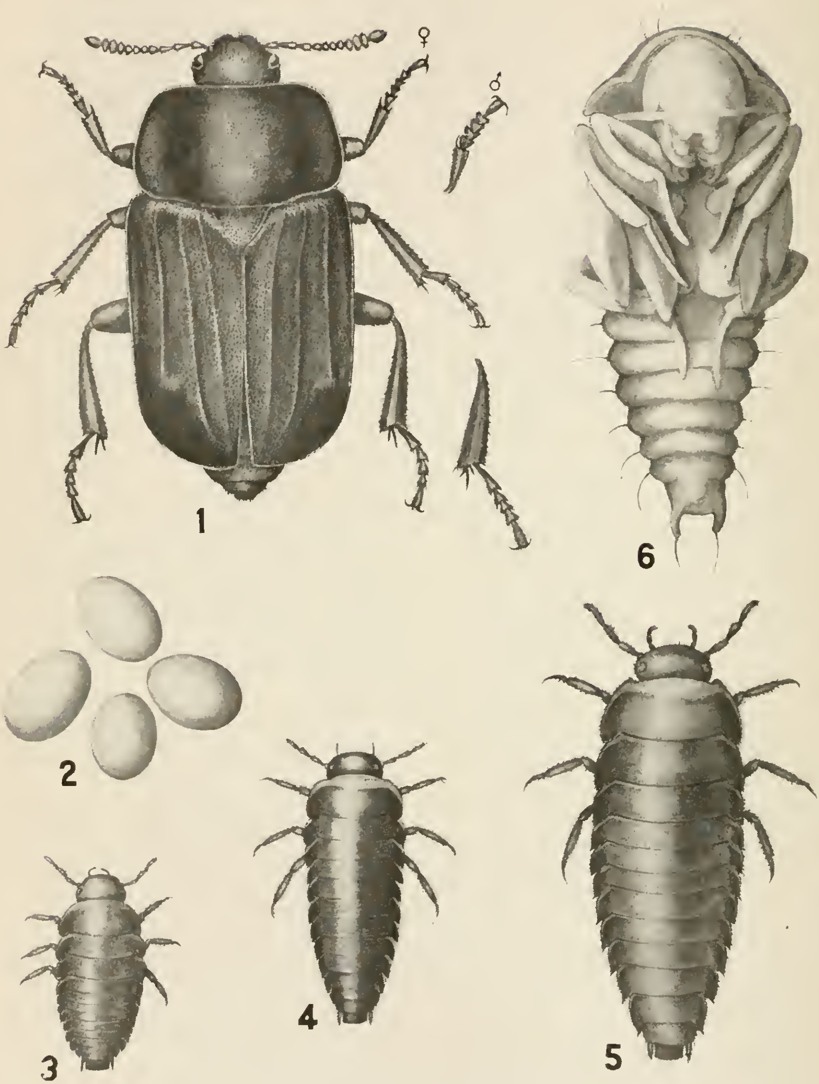
Occurrence and Injuries in Montana

The Spinach Carrion Beetle has been collected in widely separated localities in eastern Montana and is probably common throughout the state east of the divide. At times it has been found to be very abundant and injurious in the Yellowstone Valley where the only beet sugar factory in operation in the state is located. The sugar beet is the only cultivated plant which, so far as we know, is extensively injured.

The injuries take place mainly early in May, while the plants are still very small and before the work of blocking and thinning has been done. Both the larvæ and adults may be found in abundance at this time and both are injurious, though the greater part of the damage is done by the larvæ. From observation in the insectary, it is apparent that the adults live on and feed and lay eggs for a considerable length of time and the larvæ likewise are hatching and feeding over a long period. However, the insect is injurious only while the plants are small and it is probable that the period of maximum abundance comes in the season when the beet plants are small. The injury may be scattered through the field but more often occurs around the edges where frequently the plants are completely eaten off. The insects generally migrate in from some adjoining field where some one or more of the favorite food plants occur as weeds.

Descriptions of Early Stages

Egg:—Ellipsoidal, cream white, glistening, without surface markings in the chorion; 1.70 to 2.48 mm. in largest diameter by 1.30 to 1.97 mm. There is a considerable degree of variation both in size and shape of the egg, as shown in the illustration.



Spinach Carrion Beetle

1. Adult beetle. 2. Eggs. 3. First instar. 4. Second instar. 5. Third instar. 6. Pupa. All figures magnified and drawn in the same scale of enlargement.

Some are more nearly spherical than others. See Plate 5, figure 2. It has been found also that the eggs increase in size after being laid. This subject is discussed more thoroughly in another paragraph.

First Instar:—Length, 5 to 6 mm.; width of head, 1.30 to 1.80 mm.; width of body, 2.00 to 2.70 mm. All well chitinized parts, black; connecting membranes, white. Head well rounded, antennæ with three nearly equal joints, third joint with a distinct terminal sensorium beneath. Two ocelli beneath base of antennæ and group of four above. Mouthparts short and fleshy, maxillary palpi four jointed, labial palpi two jointed. The dorsal wall of the body is made up of a series of strongly chitinized, transverse plates, which project laterally and terminate posteriorly in a sharp corner. The plates of the three thoracic segments are wider than the abdominal plates, and, of these three, the anterior one is largest and the second one, intermediate in size. Segments, thirteen; segment twelve bearing a pair of two-jointed cerci. On the ventral surface, the abdominal segments, excepting the first, have transverse plates as above. The thoracic and first abdominal segments are mainly membranous. Coxæ elongated, tubular and well chitinized. Terminal segment with the dorsal and ventral walls joined, tubular. Head, including antennæ, and body, excepting membranous portions and including the legs, sparingly clothed with short bristles or spines of varying length. See Plate 5, figure 3.

Second Instar:—Length, 6.50 to 9.50 mm.; width of head, 1.70 to 2.00 mm.; width of body, 3.00 to 3.50 mm. Otherwise the second instar is like the first. See Plate 5, figure 4.

Third Instar:—Length, 11.00 to 15.00 mm.; width of head, 2.20 to 2.75 mm.; width of body, 4.80 to 5.20 mm. Otherwise the third instar is like the first and second. See Plate 5, figure 5.

Pupa:—Length 13.50 mm.; width of pronotum, 6.00 mm.; width of abdomen 5.00 mm. Entirely white, soft. Antennæ, legs and wings, free. On the anterior margin of the pronotum, on each side, are two large spines directed forward. Abdominal segments 2 to 8 inclusive, each with a long, curved bristle on each side. At the tip of the abdomen is a pair of elongations directed backward and on the tip of each is a long bristle. See Plate 5, figure 6.

First Appearance in the Spring

The adult beetles may often be found sparingly among the first insects out in the spring. They may be seen crawling on the ground before any vegetation has started. The earliest occurrence of which we have an actual record is March 15. It is quite clear that both adults and some larvæ appear long before the sugar beet crop is planted.

Egg Laying

The eggs are laid in the soil. A preference is shown for moist soil and the eggs may be found under the surface as deep as two inches. In depositing the eggs the insect may extend the tip of the abdomen into the soil for some depth or burrow under the surface. The female has been seen in the act of laying eggs in the field. The tip of the abdomen was extended down into cracks in the soil for the purpose. It is probable that in nature the eggs are always laid under the surface, though in the insectary, some were laid on the surface.

We have no records to show just how early egg-laying begins in the field. Larvæ have been found in abundance in Yellowstone County in the middle of April. Allowing a week for incubation and a few days more for feeding, since incubation, it is clearly indicated that egg-laying may begin early in April.

During two seasons we have carefully observed egg-laying in the insectary in large Riley type cages, which had about four inches of soil in the bottom. In 1911 this insect was kept under daily observation in the insectary from May 13 to July 25 and was occasionally examined until October 31. Adults brought in on May 18 began depositing in a few days and continued irregularly until July 10, many eggs being laid up to June 22.

In 1915, sixteen single females were kept isolated for egg-laying records. The experiment began on April 13 and continued until May 31 when one was still laying. From these records as well as from observations in the field, it is clear that the egg-laying period is long drawn out.

Number of Eggs Laid

As stated above, individual egg-laying records were made. The largest number laid in any one day was six, while two or three was the usual number. In many instances none were laid during a twenty-four-hour period. The largest total number laid by a single female while in confinement was seventy-five and the average was thirty-nine. These beetles were captured rather early in the season, but it is almost certain that they had laid some eggs before being brought to the insectary.

Increase in Size of Eggs During Incubation

During the course of this investigation we have had a large number of the insects in all stages under observation. The writer in some way had a suspicion that the eggs increased in size after being laid. Accordingly, individual eggs of which we had certain knowledge of the approximate time of being deposited were measured under a microscope with the aid of a filar micrometer soon after being laid and set aside to be measured again from time to time. It had been learned that it was necessary to keep the eggs in moist earth to prevent them from shrivelling. Accurate measurement records were made on fifteen eggs. Most of the eggs were measured four times. Some were measured seven times and a few only twice. Disregarding two eggs, which were allowed to go two days before the first measurement was made the increase in size ranged from 0.18 mm. by 0.25 mm. to 0.46 mm. by 0.48 mm. In a number of instances the eggs increased in size until the shorter diameter became as great as the longer diameter had been.

As they increased in size the eggs tended to become more nearly spherical though they were plump and smooth when laid. The increase in size was much more rapid soon after being laid while shortly before hatching there was practically no increase.

It was assumed that the increase was due to the absorption of moisture by osmosis.

Incubation Period

Thirty-eight exact incubation records were made in the insectary in 1915. The maximum period was 6 days, the minimum 3 days and the average 4.76 days.

The Larval Period

From hatching to the pupal condition the insect molts three times. Exact records of the stadia have been made, as follows: first stadium, maximum 8 days, minimum 4 days, average of 25 records, 5.08 days; second stadium, maximum 7 days, minimum 4 days, average of 10 complete records, 5 days; third stadium, maximum 18 days, minimum 12 days, average of 9 complete records, 14.66 days.

Habits of the Larvæ

The black larvæ are rather conspicuous objects against the green leaves of the young sugar beet plants in the field. They are easily disturbed and when frightened tumble to the ground and crawl rapidly to cover under clods of soil. Much of the time is spent hidden beneath the surface. The larvæ like the adults are adapted to a variety of food plants and their presence in a sugar beet field indicates that some one or more of the favorite plants is in the neighborhood. The beet crop probably is not generally responsible for the presence of the insects in considerable numbers in a given locality. In some instances that have come under our notice the larvæ became troublesome in beet fields only after their weed hosts had been defoliated.

The larvæ prefer to feed during the night and remain in hiding in the soil during the day, but when they are abundant in a field some may be found during the day. Both the adults and the larvæ feed from the edges of the leaves and injured plants present a characteristic appearance. The mandibles appear to be poorly adapted to make clean cuts in removing bits of the foliage and the edge of a gnawed leaf often shows a thin projection of crushed tissue.

When fully grown the larva burrows into the soil to a depth of one to two inches and constructs an oval cell in which to pupate.

Duration of Pupa Stage

All individuals forced to pupate in tin cans with insufficient earth

for forming pupal cells transformed to the adult condition uniformly in 12 days. Others that were fed over dirt and allowed to pupate in the soil emerged as adults in 23 to 26 days after disappearing into the earth. This would seem to indicate that 11 to 14 days were spent in the earth before actual pupation took place. However, the temperature in the tin cans was higher than that in the soil and this would tend to diminish the pupal period in the cans below normal. Other insectary notes which we have indicate a prepupal period of 7 to 9 days. It is probably safe to say, therefore, that in the insectary the period in the soil is about 25 days and the pupal period is about 18 days.

Habits of the Adults

A few days after emerging the adults are indistinguishable from those that have passed the winter in hibernation and have reproduced. They are ready to eat soon after emerging and in our cages ate freely for a few days and then disappeared into the earth. They came out again from time to time and ate food but gradually spent more and more time in the soil until in the fall they were seldom seen.

Hibernation

From the fact that we have traced the adults well into the fall and have found them very early in the spring, as well as from the fact that we have no evidence of the occurrence of larvæ or pupæ in the fall, we have concluded that this insect hibernates as adults and only as adults. It is quite certain that the adults pass the winter buried in the soil.

Number of Broods

The complete life cycle has been accounted for at least three times in the insectary, and no evidence has been found in the field that does not harmonize with the results of insectary studies. The oviposition is long drawn out, as has been shown in a previous paragraph, and this fact readily accounts for the occurrence of larvæ during a prolonged period in the early part of summer. These facts, together with the direct evidence which we have that newly emerged adults disappear into the soil for the season without depositing eggs, make it clear that there is but one brood of *Silpha bituberosa*, at least, at Bozeman, Montana.

Food of the Species

Dr. James Fletcher states that *Silpha bituberosa* feeds on *Chenopodiaceæ* and specifically mentions spinach and beet as host plants. He also records *Monolepis nuttalliana* (*chenopodioides*), *Chenopodium album* and squash and pumpkin, vines of which the latter two, he says,

are sometimes seriously injured. Chittenden (Bulletin 43, Bureau of Entomology, 1903) has recorded the sugar beet as being fed upon.

In Montana, we have found the insect feeding injuriously only on the sugar beet and have found both adults and larvæ feeding abundantly on *Monolepis nuttalliana* and *Solanum triflorum* and adults only on alfalfa. We have also seen the larvæ feeding in considerable numbers on young wheat. The three weeds mentioned should be looked upon as the normal food plants of this insect and the seat of the difficulty. They are weeds of cultivated fields and do not occur on soil that has never been broken.

It is not clear whether or not *Silpha bituberosa* feeds normally also on carrion. In 1910 larvæ and adults were placed with carrion in cages and as controls other species of the genus known to feed on carrion were placed in other cages under like conditions. *Silpha bituberosa* fed very sparingly, if at all. It was not seen in the act of eating while the other species ate freely. The larvæ have been seen to eat living pupæ of the same species and on one occasion one larva out of a lot that had not been given sufficient vegetable food was seen to be eating on the tail of a dead mouse.

To the writer, who has been observing the species for several years, it seems clear that both larvæ and adults feed normally on a wide variety of green vegetable foods and seldom, if ever, feed on carrion, as do other members of the genus *Silpha*. On one occasion when larvæ and adults were found to be abundant and destructive in a rather closely localized region in a field of young beets, an attempt was made to find carrion in the locality, but none could be found and the farmer stated that he did not know of any in the neighborhood.

Remedies

From the fact that the insects commonly migrate into beet fields from weedy places near by, it is plainly indicated to be desirable to practice clean farming, keeping the vicinity of beet fields as free of weeds as possible.

At the time the larvæ and adults of this insect are injurious to beets the plants are generally quite small. Sometimes the mere seedlings are attacked. It is not feasible, then, to destroy the insects by poisoning the beet plants, unless, as is sometimes the case, the plants have become large enough to have a considerable expanse of foliage when some arsenical could probably be used effectively.

One writer has recommended that seeds of *Monolepis nuttalliana* be sown as a trap crop on which to poison the insects. The writer is not certain that this would be effective. It is feared that the insects could not be destroyed by spraying with an arsenical with sufficient

thoroughness to protect nearby sugar beets. It seems to be more desirable to recognize and destroy its favorite food plants and resort to the use of poisoned bran mash as soon as the insects are detected either on cultivated crops or on weeds.

In the season of 1915 at the suggestion of Assistant Entomologist J. R. Parker, of this office, a test of poisoned bran mash as a means of killing these insects was made at the Huntley Substation by Mr. Dan Hansen, who is in charge of the Station for the Office of Western Irrigation Agriculture, Bureau of Plant Industry, United States Department of Agriculture. Poisoned bran mash, prepared by the usual formula, was scattered among the weeds near the beet field where the insects were present in great abundance. The insects ate the mash greedily and the next day the dead insects could be found on the ground in great abundance and no living ones were seen. Mr. James Scilly, formerly agriculturist of the Billings Sugar Company, reported that he had placed the poisoned bran mash under burlap bags in the beet fields and stated that the adult beetles were attracted by the covering afforded and were killed by eating the poison.

President C. Gordon Hewitt: If there is no discussion, the next paper will be given by Mr. C. H. Richardson.

THE RESPONSE OF THE HOUSE-FLY TO CERTAIN FOODS AND THEIR FERMENTATION PRODUCTS[1]

By C. H. Richardson, *College of Physicians and Surgeons, Columbia University, New York City*

Any economic study of the house-fly must obviously take into consideration the subject of food, for it is usually during its search for food that this insect is most intimately associated with man. That the house-fly has decided food preferences has already found expression in the various baits now used in fly traps. Previous studies on baits have been made largely with complex food mixtures and while they form a valuable contribution, it is felt that a more intimate knowledge of the attractive constituents of these preferred foods is highly desirable.

The experiments that form the basis of this paper were therefore conducted largely with solutions of known chemical compounds found in certain foods or their fermentation products which are eagerly sought by house-flies. They were performed at New Brunswick, N. J.,

[1] Published by permission of the Director of the New Jersey Agricultural Experiment Station.

during the summer of 1916 and form a part of a larger project on the responses of the house-fly to environmental factors undertaken by the Entomological Department of the New Jersey Agricultural Experiment Stations. (Richardson 1916.)

A study of the food preferences of this insect is beset with numerous difficulties. Temperature and light affect the abundance, but more puzzling is the great difference in numbers often noted on two consecutive days when conditions of temperature, moisture and light appear to be nearly uniform. Many explanations are offered such as the appearance of new broods, disposition to migrate and the desire to vary the diet. These conditions necessitate the repetition of all experiments as isolated tests may lead to erroneous conclusions. The data given here must be considered as a preliminary treatment of this subject, awaiting further verification and extension.

Historical

Morrill (1914) studied the response of the house-fly to a variety of foods, some of the results of which have a direct bearing on the present investigation. Sucrose was comparatively unattractive when used in aqueous solution with formaldehyde. The addition of ethyl alcohol (95 per cent), one part to twenty parts of water, increased its attractiveness. Vinegar in combination with sucrose was eagerly sought by house-flies. This may be due to the acetic acid contained in it. Ethyl alcohol when added to beer did not form an attractive mixture. This result can probably be explained by the fact that American beers have an alcohol content close to the optimum for the house-fly. The addition of alcohol would render it less attractive. Morrill's studies point out the irregularity of response to the same bait on different days.

Buck (1915) conducted a similar series of experiments. He found that not less than 3 per cent nor more than 8 per cent of 95 per cent ethyl alcohol in water was a good bait. Sucrose was also found to be a valuable addition to various baits, sometimes increasing their attractiveness from 10 to 20 per cent.

Methods

The experiments which are described here were performed on a shelf along the south side of a barn in a well-lighted location where flies were always plentiful. Screen-wire fly traps, $9\frac{3}{4}$ inches high and 6 inches in diameter were used in all experiments. The screen was given a coat of spar varnish to prevent rusting. White glazed earthenware dishes, 122 mm. in diameter with a capacity of 125 cc. were used as containers for the solutions. The metal trap pans and dishes were

carefully washed at the conclusion of each experiment. All solutions were made with distilled water.

The traps were placed in a linear series along the shelf three feet apart. Special care was exercised that no trap contained the same material or occupied the same position in the series in two consecutive experiments. Unless otherwise stated only one portion of a substance was used in each test.

The results given apply only to the house-fly (*Musca domestica* L.) which made up more than 95 per cent of the catches during the summer.

Experiments with Carbohydrates

Because of the prevalence of carbohydrates in foods to which the house-fly is attracted, it was decided to test them rather thoroughly. Glucose (dextrose), fructose (levulose) and galactose were chosen from the monosaccharides; maltose, lactose and sucrose (cane sugar) from the disaccharides; and dextrin and starch from the polysaccharides. Solutions of 1 gram, 2 grams and 5 grams to 50 cc. of water were employed and 50 cc. were placed in each trap. The experiments with galactose were not completed owing to the difficulty of obtaining this compound. The results are expressed in the following table:

Experiments on Carbohydrates

Material in 50 cc. dist. water	1 gm. 7/12 –15 75 hrs.	1 gm. 7/15 –18 67 hrs.	1 gm. 7/14 –18 89 hrs.	2 gm. 7/20 –21 28 hrs.	5 gm. 8/23 –25 22 hrs.	5 gm. 8/23 –25 41 hrs.	5 gm. 8/25 –28 76 hrs.	5 gm. 8/29 –30 20 hrs.	5 gm. 8/30 –31 24 hrs.	5 gm. 8/31 –9/2 45 hrs.	5 gm. 9/2–4 47 hrs.	Total last 4 expts.	Avge. last 4 expts.	Avge. last 6 expts.
Glucose (dextrose)			3	1				11	5	1	9	26	6.5	
Fructose (levulose)								3	1	5	76	85	21.2	
Galactose			0	63										
Maltose			1	14	2	21		5	2	1	8	16	4	6.5
Lactose			0	0		90	62	14	24	1	13	52	13	34
Sucrose			0	2		7	6	2	2	7	2	13	3.2	4.3
Dextrin					2	23		3	44	28	35	110	27.5	22.5
Starch	1	2						1	2	1	5	9	2.2	
Control (water)			0[1]	4[1]										

[1] Two traps used in experiment.

On the whole these carbohydrates in aqueous solution were not very attractive to house-flies. Considering all the experiments, lactose caught the largest number of flies (204), starch the least (12). Dextrin also caught a comparatively large number of flies (135). Sucrose was consistently a poor bait, catching but 26 flies in six experiments. From the foregoing tests, I believe it can be safely stated

that the common carbohydrates in freshly prepared aqueous solution are not eagerly sought by house-flies.

Experiments with Alcohols and Acids

Foods containing large amounts of fermentable carbohydrates decompose with the formation of an extensive series of compounds, prominent of which are ethyl alcohol, carbon dioxide, acetic acid, lactic acid, a mixture of amyl and other higher alcohols called fusel oil and succinic acid. Of these ethyl alcohol, technical amylic alcohol (which contained a mixture of isoamyl and d-amyl alcohols, the former predominating) and acetic acid were used in six experiments and lactic and succinic acids in two experiments. Concentrations of 4 and 10 per cent were used for each compound except succinic acid. The results of these experiments follow:

Experiments on Alcohols and Acids

Material 50 cc.	8/28–29 22 hrs.	8/29–30 20 hrs.	8/30–31 24 hrs.	8/31–9/2 45 hrs.	9/4–7 66 hrs.	9/7–8 30 hrs.	Total	Av. per expt.	Av. per hr. (all experiments).
4% Ethyl Alcohol	146	67	37	82	14	545	891	148.5	4.3
10% Ethyl Alcohol	19	21	12	156	3	333	544	90.6	2.6
4% Amylic Alcohol (tech)	142	123	106	292	17	576	1,256	209.3	6.0
10% Amylic Alcohol (tech)	203	41	31	59	7	778	1,119	186.5	5.4
4% Acetic Acid	88	22	2	101	4	235	452	75.3	2.1
10% Acetic Acid	173	11	4	17	8	1,029	1,242	207	6.0
4% Lactic Acid	5	5					10	5	0.2
10% Lactic Acid	39	11					50	25	1.1
4% Succinic Acid	64	12					76	38	1.8

Four per cent ethyl alcohol caught 891 flies; 10 per cent 544 flies; 4 per cent amylic alcohol was considerably more attractive, catching 1,256 flies, while 10 per cent amylic alcohol caught 1,119 flies; 4 per cent acetic acid caught 452 flies, 10 per cent 1,242 flies, or nearly as many as the 4 per cent amylic alcohol. However, a comparison of the individual experiments shows that amylic alcohol gave more consistent results than acetic acid. Four per cent amylic alcohol was more than twice as attractive as 10 per cent acetic acid in four experiments while the acetic acid was more attractive, though not twice so, in two experiments. The results with lactic and succinic acids showed some attraction in two experiments.[1]

[1] Experiments made by Barrows (1907) on *Drosophila ampelophila* Loew. (Journ. Expt. Zoöl., Vol. IV, No. 4, pp. 515–537) showed that this insect responded positively to amyl alcohol, ethyl alcohol, acetic acid and lactic acid, but that the most pronounced response was to a solution containing 2½ per cent ethyl alcohol and 5/8 per cent acetic acid.

Experiments with Carbohydrates in Solution with Acetic Acid and Alcohols

Mixtures of maltose, lactose, sucrose and dextrin with ethyl alcohol, amylic alcohol and acetic acid were made, using five grams of the carbohydrate to fifty cubic centimeters of solution. The alcohols and acetic acid were made up in 4 per cent concentrations. The results are stated in the following table:

Experiments on Carbohydrates with Alcohols and Acetic Acid

Material 5 gm. in 50 cc.	8/22-23 22 hrs.	8/23-25 41 hrs.	8/25-28 76 hrs.	Total	Av. per Expt.	Av. per hour
Maltose and dist. water	2	21		23	11.5	0.3
Maltose and 4% ethyl alcohol	0	500		500	250	7.3
Maltose and 4 per acetic acid	5	100		105	52.5	1.6
Maltose and 4 % amylic alcohol (tech)	638	440		1,078	539	17.1
Lactose and dist. water		90	62	152	76	1.2
Lactose and 4 % ethyl alcohol		160	200	360	180	3.0
Lactose and 4% acetic acid		60	175	235	117.5	2.0
Lactose and 4% amylic alcohol (tech)		270	450	720	360.	6.1
Sucrose and dist. water		7	6	13	6.5	0.1
Sucrose and 4% ethyl alcohol		155	78	233	116.5	1.9
Sucrose and 4% acetic acid		75	28	103	51.5	0.8
Sucrose and 4% amylic alcohol (tech)		550	380	930	465.0	7.9
Dextrin and dist. water	2	23		25	12.5	0.3
Dextrin and 4% ethyl alcohol	11	400		411	205.5	6.5
Dextrin and 4% acetic acid	0	150		150	75	2.3
Dextrin and 4% amylic alcohol (tech)	2	944		946	473	15.0

In every case the attractiveness of the carbohydrates was increased by the addition of amylic alcohol, ethyl alcohol or acetic acid. Amylic alcohol was more effective when used with carbohydrate than when used alone; indeed, with maltose and dextrin it appeared to be remarkably attractive. Ethyl alcohol was more attractive with maltose and dextrin than when used in aqueous solution, but less so when used with lactose and sucrose. Acetic acid seemed to be about as attractive when used alone as when added to solutions of the carbohydrates employed in these experiments.

Experiments with Other Food Substances

Wheat Flour:—The fact that bread has some value as a fly bait, especially when added to other mixtures, led to a study of the attractive constituents of wheat flour. Owing to a lack of time, it was not possible to carry this investigation very far.

Starch and two proteins, gliadin and glutenin make up the larger part of wheat flour. I have already spoken of the unattractiveness of starch. The present experiments concern the effectiveness of certain proteins and the water soluble portion of white flour.

By kneading white flour dough in water till practically all the starch granules are detached, it is possible to prepare a substance consisting largely of gliadin and glutenin known as crude gluten. The crude gluten cannot be entirely freed of water soluble substances by this method. Small amounts of crude gluten in water attracted only six flies, in two experiments, while equal amounts of white flour in water captured 332 flies. In view of the poor success of crude gluten it did not seem advisable to try gliadin and glutenin separately.

Solutions of the water soluble ingredients of white flour contained, besides the starch granules in suspension, a number of water soluble proteins, especially albumin and proteose, organic and inorganic salts and small amounts of many other compounds. Three traps containing solutions of 1 gram of total dissolved substance to 50 cc. of water caught 2,112 flies. In othei experiments three traps containing 1.35 grams each of dissolved material attracted 225 flies and 2.5 grams in two traps, 855 flies.

Solutions containing the water soluble ingredients without starch in suspension gave with 0.1 gram concentrations in 50 cc. of water the following results: three traps a total of 4 flies; two traps a total of 2,400 flies.

The experiments indicate that there is something present in these aqueous solutions of white flour which strongly attracts house-flies. Experiments which extended over a period of 67 to 75 hours were on the whole more successful than those whose duration was shorter, 23 to 48 hours. These solutions improve on standing, apparently due to the formation of certain fermentation products.

Milk:—A few experiments were made on milk, prompted by the fact that it is a uniformly good fly bait. Fresh milk was acidified with dilute acetic acid till the caseinogen was precipitated. The liquid portion was separated from the caseinogen, which held much butter fat, by filtration. The caseinogen-fat mixture was unattractive to house-flies in two experiments. Fat-free caseinogen caught 77 flies in one experiment while butter fat (ether extract) caught only two flies.

These tests indicate that fat-free caseinogen is somewhat attractive to house-flies but are not conclusive. The experiments on carbohydrates, as already stated, show that flies are not attracted to milk sugar (lactose) in large numbers.

Practical Application

While it was not possible to subject any of the materials used in this investigation to rigorous field tests, a few experiments indicated that the water soluble part of wheat flour, technical amylic alcohol, and molasses solution containing amylic alcohol have considerable value as fly baits. The aqueous wheat flour solution was made up with 1 gram of sodium arsenite and 4 cc. of amylic alcohol to each 100 cc., the molasses was diluted with water 1 to 2 or 1 to 3 and the same amounts of sodium arsenite and amylic alcohol were added. The materials were exposed in shallow dishes. Many flies were poisoned, but without control over the breeding places it was impossible to effect a permanent reduction in their number. It should be added that amylic alcohol has certain drawbacks. It evaporates rather quickly and is only slightly soluble in water rendering an even mixture difficult.

Conclusions

The following conclusions are drawn from these experiments:

(1) Glucose, fructose, maltose, lactose, sucrose, starch and dextrin were not very attractive to house-flies. Lactose and dextrin caught the largest number of flies, starch the least. Sucrose was consistently a poor bait.

(2) Four per cent amylic alcohol gave better results than ethyl alcohol, or acetic acid in 4 or 10 per cent concentrations and better than 10 per cent amylic alcohol. Four per cent ethyl alcohol was better than 10 per cent, 10 per cent acetic acid gave better results than 4 per cent. Succinic and lactic acids showed some attractive qualities in two experiments.

(3) Maltose, lactose, sucrose and dextrin in 4 per cent solutions of amylic alcohol, ethyl alcohol and acetic acid were more frequently visited by house-flies than the corresponding aqueous solutions. Maltose and dextrin solutions were more effective than lactose or sucrose. The order of response to the alcohols and acetic acid containing carbohydrate was the same as that for the aqueous solutions of these compounds.

(4) Crude gluten from wheat flour was not attractive. The water soluble portion with or without starch in suspension was decidedly attractive.

(5) Several experiments with milk indicate that fat-free caseinogen is attractive while butter fat is not.

(6) Experiments indicate that aqueous solutions of wheat flour and molasses to which sodium arsenite and amylic alcohol are added have considerable value as poisoned baits for house-flies.

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PRESIDENT C. GORDON HEWITT: This paper is now open for discussion.

MR. MAX KISLIUK, JR.: In the Bureau of Entomology during the summer of 1915, Mr. Hutchinson and I performed several baiting experiments similar to the ones reported by Mr. Richardson. Among some of the materials used was blood of pigs secured from a slaughterhouse. We tested sample traps and found that pig blood was very attractive—more so than any other material tried. Its odor, however, is very disagreeable to man, although it apparently attracts flies very strongly.

PRESIDENT C. GORDON HEWITT: The next paper will be read by Mr. W. E. Britton.

RECENT ANTI-MOSQUITO WORK IN CONNECTICUT

By W. E. BRITTON, *New Haven, Conn.*

At the Cleveland meeting of this Association, four years ago, the writer presented figures showing that in 1912 some 2,697 acres of salt marsh in Connecticut were ditched to prevent mosquito breeding (See JOURNAL OF ECONOMIC ENTOMOLOGY, vol. 6, p. 89).

In 1913 a contract was awarded for the elimination of all mosquito-breeding places in Greenwich from the shore inland for a distance of about two and one-half miles, at a cost of $15,500. The major portion of the work related to inland breeding places such as fresh water swamps, the overflow from springs, and surface pools, but a small portion consisted of tide-water marsh which was ditched. The work was not finished until 1914.

Greenwich was formerly a malaria ridden community; it has been unofficially estimated on good authority that 900 cases of malaria occurred there in a single season. In 1914 up to September it was reported that there had been only 36 cases, of which only 15 were new ones. Since, according to several reports, there has been no malaria in Greenwich except a few hold-over cases. At any rate it seems to be

generally understood that this anti-mosquito work has had a most marked effect in reducing malaria in the town.

In the year 1914 about 310 acres were ditched on the Hammonasset salt marsh in the town of Madison.

The General Assembly of 1915 enacted a law giving the Director of the Agricultural Experiment Station authority, whenever funds have been raised for the purpose, to order mosquito-breeding eliminated in any swamp or marsh, and when the work has been done and duly approved by him, the town must maintain it afterwards. Unfortunately this measure carries no appropriation, so that the money must be raised in some other way before any work can be started. So far practically all ditching on the salt marshes in Connecticut has been done from money raised by voluntary contributions. In one or two cases small municipal appropriations have been made.

In 1915 a small area of about four acres in New Haven was ditched late in the season. But the season just closed has proved to be the banner year for ditching salt marshes in Connecticut, and the work done involves about 2,900 acres. A large portion of this acreage was ditched by contract,—the largest contract of its kind ever executed in Connecticut—including all salt marshes between Branford river and Hammonasset river. This covers a distance of about fifteen miles in a straight line, or following the sinuosities of the coast, about twenty miles. It includes all salt marshes in the towns of Madison and Guilford, more than half of such area in Branford, and a few acres in Clinton, or a total of about 2,668 acres. The cost was about $20,000.

In Saybrook during September ditches were cut in two small areas of salt marsh totaling about one hundred and fifty acres, and during October and November, a small tide marsh of about ninety acres in Orange, near New Haven, was ditched.

Thus of the total area of 22,264 acres[1] of tide-water marsh in Connecticut, several hundred acres must have been filled by electric and steam railroad companies, for freight yards and docks, by cities and towns for highways, by individuals and corporations for building sites. More than 6,000 acres, or apparently about one third of the remaining salt marsh area has already been ditched. All ditches cut in 1912 and since have been maintained in workable condition.

Bills are now being prepared for presentation to the convening legislature providing for the extension of the ditching system to cover all salt marshes in the state within a period of, perhaps, six years. Legislation will also be sought providing for state supervision of maintenance work, one half the cost being charged to the towns in which the marsh areas are situated.

[1] D. M. Nesbit, Miscellaneous Special Report, No. 7, The Tide Marshes of the United States, U. S. Department of Agriculture, 1884.

In addition to the tide-water marshes mentioned, several inland areas have been rendered immune as regards the breeding of mosquitoes. For instance, in the town of Hamden near New Haven, some swampy land is owned by the New Haven Water Company and the Winchester Repeating Arms Company. The latter is now building a dam and pumping station by means of which the water from about fifty acres of land owned by this corporation may be pumped over the dam into Lake Whitney. By raising the dam of this lake 18 inches the New Haven Water Company will flood about fifty acres of its own land. This treatment will prevent the breeding of mosquitoes on about one hundred acres of fresh-water swampy land, now a prolific source of malaria mosquitoes.

Several projects are now under way for work next year. The city of New Haven, for instance, has appropriated $10,000 for the purpose of ditching all remaining marshes within its limits.

It is evident, therefore, that Connecticut is making some progress in solving her mosquito problems.

President C. Gordon Hewitt: If there is no discussion, we will now listen to a paper by Mr. E. N. Cory.

THE PROTECTION OF DAIRY CATTLE FROM FLIES [1]

E. N. Cory, *College Park, Md.*

In 1914 the herdsman of Maryland Agricultural Experiment Station requested the writer to recommend a spray suitable for protecting the dairy cattle from flies. A spray of 6 per cent emulsion of pine tar creosote was recommended and used with excellent results for the balance of that season and during the following summer. Previously, proprietary coal tar products had been used, but several complaints had been received to the effect that the butter made at the Station was very perceptibly tainted with the coal tar odor. No complaints were made of a similar nature after the pine tar creosote was adopted. Personal examination of the butter showed no trace of creosote odor.

In 1916, a project was outlined with the object of ascertaining the minimum effective strength of pine tar creosote emulsion and the best spraying procedure with special emphasis on the length of time a single spraying was effective and the comparative value of morning and afternoon sprayings.[2]

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[1] Contribution from the Entomological Department of the Maryland Agricultural Experiment Station.

[2] This project is in coöperation with the Department of Animal Husbandry of the Maryland Agricultural Experiment Station.

The emulsion was made by using $\frac{2}{3}$ lb. of caustic soda, 98 per cent pure, dissolved in a known quantity of water, for every gallon of pine tar creosote to be emulsified, and the subsequent dilution with cold water to the desired strength. This emulsion is very stable and slightly alkaline.[1]

In the preliminary tests, the herd was divided into two equal lots; one being sprayed with 1 per cent emulsion, and the other lot, with 2 per cent emulsion.

The herd was sprayed each afternoon just prior to milking (about 3 p. m.), and notes made of the effect on fly prevalence, the effect of the spray on flies actually hit, and the effect on the hide and exposed mucous membrane.

This test ran for three days and then 3 per cent and 5 per cent emulsions were substituted for a test of three days' duration.

Immediately after the application, all flies left the cattle or fell to the floor. Some few returned to parts of the animals that were not touched by the spray, through careless work. However, for the time, the cattle were approximately fly-free, and remained so until they were again turned out to pasture.

The best indication of the effect of the spray was in the cessation of the switching of tails, which, previous to the spraying, were in constant motion.

The flies that were hit, fell to the ground in a more or less bedraggled condition. Some recovered after 10 to 12 hours, confined in a wire cage, though most of those that fell to the floor were killed by all the strengths of the emulsion. The 3 and 5 per cent emulsions killed all flies that were thoroughly wetted.

Throughout the duration of the experiments, very careful daily examinations failed to reveal the slightest damage to hair or skin or to the exposed mucous membranes of the eyes or nostrils.

At first the cows were afraid of the spray when directed at their faces, but, later, many became used to the spray and hardly moved during the application.

The preliminary tests showed 3 per cent emulsion to be the most effective minimum strength, and this was adopted in the subsequent tests.

Using 3 per cent emulsion, one third of the herd was sprayed every day; one third, every other day; and the balance, every third day, to ascertain the lasting quality of the emulsion.

It was found that the mixture was fully effective only one day,

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[1] This formula was supplied by Mr. C. D. Vreeland, then of the Vreeland Chemical Company. The pine tar creosote has since been obtained for us by the same gentleman through the Kilton Chemical Company.

though there was considerable protection afforded for two and even three days. To accord full protection, the cows should be sprayed each day.

In the third phase, the comparative value of morning and afternoon applications was tested. The cows were sprayed between 3 and 4 a. m. prior to milking, and were then turned out to graze. Observations in the field during this period showed the cows to be very little troubled by flies, and grazing or resting quietly. When they came in to be milked, there were few flies on the animals. The cows were quiet during the milking and did not exhibit the extreme nervousness displayed prior to the spraying.

The fourth test consisted of taking the records of the herd, half of which was sprayed once a day in the morning, with 3 per cent emulsion, and the balance left unsprayed. These notes are of a preliminary nature, and afford a possible index of what may be expected. The future tests will be on farrow cows, so maintained for a sufficient period to yield results. The indications from the preliminary records are that an increased average yield should result from protection from flies. Such an increase was obtained in this test.

The cost of the spraying was less than one-half cent per cow per application.

President C. Gordon Hewitt: This paper is open for discussion.

Mr. T. J. Headlee: Are there any figures on the increased yield of milk? The treatment costs half a cent a day per cow. What is the benefit?

Mr. E. N. Cory: We know that our results are open to several experimental errors. The cows selected were hardly a representative lot, and yet comparing the record of the ten days prior to spraying with the ten days during the spraying period, we found there was an average increase of three pounds of milk per animal. The work next year will be continued over a longer period and we hope to get more definite figures on milk production.

Mr. R. A. Cooley: What were the species of flies concerned?

Mr. E. N. Cory: The principal flies were the horn-fly, *Hæmatobia serrata* and the stable fly, *Stomoxys calcitrans*.

President C. Gordon Hewitt: The point raised by Doctor Headlee is an important one in connection with all these experiments on insects affecting cattle. Everyone knows how difficult it is to convince the farmer to undertake any very unusual measures for control of insects affecting his cattle, and he has to be convinced and convinced very strongly that good results will follow. Unless you have actual figures in regard to the effect of the flies on the cattle, without repel-

lents and with repellents, you are likely to have a very difficult task in persuading farmers to use them, even though you are perfectly convinced that they are effective. I will now call on Mr. C. W. Howard to give his paper.

INSECT TRANSMISSION OF INFECTIOUS ANEMIA OF HORSES

By C. W. Howard, *St. Paul, Minn.*

(Withdrawn for publication elsewhere)

President C. Gordon Hewitt: This is a very interesting subject to entomologists, especially those in the Western States and the paper is now open for discussion.

Mr. R. A. Cooley: I am not prepared to make any contribution on this subject but I trust Mr. Howard may receive every encouragement in his work.

President C. Gordon Hewitt: The next paper will be read by Mr. Herbert Osborn.

THE ECONOMIC IMPORTANCE AND CONTROL OF MIRIS DOLOBRATA

By Herbert Osborn, *Columbus, Ohio*

(Withdrawn for publication elsewhere)

President C. Gordon Hewitt: If there is no discussion I will call for a paper by Mr. George G. Ainslee.

CRAMBID MOTHS AND LIGHT[1]

By Geo. G. Ainslie, *Entomological Assistant,*
Cereal and Forage Insect Investigations, Bureau of Entomology

In entomological literature there are many conflicting and confusing statements concerning the value of trap lanterns and poisoned baits in reducing the numbers of night flying moths of injurious species. The efficiency of a trap lantern depends largely on the time in the life of a moth at which it can be attracted, that is, whether before, during or after the period of egg deposition. Also the number of moths appearing at light means but little unless the sex is known and, in the case of females, the condition of the ovaries. To throw some light on

[1] Published by permission of the Secretary.

these questions a series of night collections was made at the United States Entomological Laboratory at Nashville, Tennessee, during the summer of 1915. The moths of the subfamily *Crambinæ* were particularly studied.

Concerning these moths Felt states,[1] in giving the results from a series of trap lanterns operated at Ithaca, New York, in 1889 and 1892, that "an examination of the record of any species . . . will show that the greater number taken were males, except *Crambus laqueatellus* where the females were in excess. If we accept the strong probability that one male can fertilize several females the trap lantern is of little value. . . . The females fly but little before most of the eggs are laid, consequently the trap lantern as a practicable means of checking the increase of these insects is of no value." As an opposed view Osborn says[2] in speaking of *Crambus vulgivagellus* and *exsiccatus*, now known as *trisectus*, "the moths are strongly attracted to light and for *exsiccatus* at least, the attracted individuals are in large part females loaded with eggs; so, for this species, there can be no question as to the value of trap lights."

At least fourteen species of the *Crambinæ* occur at Nashville and first and last representatives of nearly all of them have been taken at light. The great bulk of the material, however, was of *Crambus teterrellus*, a very common and widely distributed species and it is to this species that the data here given and the conclusions drawn directly apply. The smaller amount of data obtained with other species agrees on the whole with these conclusions and makes them applicable to more than the single species. Indeed, it was found that the same principles held good in the case of several species not Crambids, for example, *Nomophila noctuella*, *Acrolophus popeanella*, *Xanthoptera nigrofimbria* and *Feltia subgothica* and *gladiaria*, though the data regarding these species are much more fragmentary and inconclusive than with the Crambids.

The collections were made at the strongly lighted windows of the laboratory building and at my residence adjoining, one window of which seemed particularly attractive to the moths. The lights were started at dusk and the moths collected in vials as fast as they appeared. Those taken during each 15-minute period were kept separate and the sex of each individual determined. Collections were continued throughout the night and until the lights ceased to attract because of the brightening dawn. Generally one man could make the round of the windows in the fifteen minutes but at times it required two or even three to capture all the moths as fast as they appeared. On the night

[1] Cornell Bul. 64, p. 52.

[2] Insect Life, vol. VI, p. 72.

of September 7–8 we took 7,368 moths of *Crambus teterrellus*, 468 of them in the single 15-minute period from 7.15 to 7.30. The interest and faithfu'ness of Mr. W. B. Cartwright, my assistant at the time, deserve mention and I am glad to acknowledge my indebtedness to him.

Collections were made on 18 full nights between the first of June and the middle of October. Collections were attempted on numerous other occasions but during the night the weather conditions became such that the moths ceased to come so none of those records are included in the present discussion. No moths of *teterrellus* appeared on October 7 or 12. On the remaining 16 full nights of collecting 19,655 *teterrellus* moths were taken, an average of 1,228 per night. The largest number taken on one night was 7,638 on September 7, and the smallest number, 7, on October 1.

Teterrellus is a species without distinct generations and the moths are quite uniformly abundant from the time they first make their appearance in the spring until about the end of September when they disappear for the year. Their numbers often diminish during a prolonged dry spell in the summer but increase quickly with renewed rains, these conditions seemingly having more influence on their abundance than any periodicity of generations.

Of the total of 19,655 moths taken 13,318, or 67.8 per cent, were males and 6,337, or 32.2 per cent, females. As can be seen from Chart A the percentage of males varied on different nights from 32.7 to 100. On only five nights did the number of females taken exceed the males, the total excess for the five nights being but 312. It was very soon noticed that the great majority of the females appeared very shortly after dusk, generally within an hour and that comparatively few of the males came early in the evening. After the first flight was over there was an interval of comparative quiet after which the numbers again increased but more gradually than before. This increase consisted altogether of males and continued until the totals attained were greater than during the first flight. The maximum of this second or male flight was reached generally between 11.30 and 1.30. Chart B in which the total collections for the season are graphically represented for each 15-minute period of the night shows this relation of the sexes at a glance. It will be noticed that the females have reached their peak and as suddenly subsided by 8.30, from which time there is a very uniform and gradual decrease in their numbers until daybreak. Chart C is a representation of the facts in another form. By reference to Chart D it will be seen that over 41 per cent of the females have come by 8.30. The males, on the other hand, have scarcely begun to come by 8.30, only 3.9 per cent of their total number having appeared.

The peak of the female line is reached at 7.30, that of the male line not until 12.45. Fifty per cent of the females have appeared at 9.15 and 75 per cent at 11.45, while of the males 50 per cent have not come till 12.15 and 75 per cent until 1.45. The peak representing the male flight is much broader than that of the female flight and attention is called to the fact that the female peak should be even more constricted than it is for no correction has been made for the error caused by the earlier setting of the sun later in the season. As will be seen from Chart A, the time for the collection of the first moth moved back from 8.15 p. m. on June 3 to 7.00 p. m. in late September and October. If

Chart A. Seasonal Records Arranged by Date of Collection

Date of Collection	Temperature			Time of Flight		Moths Taken				
	Max.	Min.	Mean	First P.M.	Last A.M.	Total	♂	%♂	♀	%♀
June 3	69	60	63.3	8.15	3.30	64	35	54.7	29	45.3
July 22	65	55	58.8	7.45	3.45	609	528	86.7	81	13.3
26	75	63	69.4	7.45	4.00	460	179	38.9	281	61.1
30	81	72	77.4	8.00	4.00	211	79	32.7	132	67.3
Aug. 3	73	63	68.0	7.45	4.15	192	83	43.2	109	56.8
10	70	68	68.9	7.30	4.30	362	276	76.2	86	23.8
13	74	66	68.9	7.30	4.15	727	476	65.5	251	34.5
17	76	70	72.4	7.15	4.30	1,244	917	63.7	327	26.3
24	78	63	69.6	7.15	4.45	641	285	44.5	356	55.5
31	56	51	53.9	7.00	2.30	185	97	52.4	88	47.6
Sept. 3	68	58	61.6	7.45	5.00	5,253	3,789	72.2	1,464	27.8
7	75	62	65.8	6.45	5.15	7,638	5,501	72.0	2,137	28.0
14	76	67	70.9	6.45	4.45	1,660	879	53.0	781	47.0
16	80	68	72.3	7.00	4.45	394	180	45.7	214	54.3
28	72	62	65.3	7.00	3.45	8	7	85.5	1	14.5
Oct. 1	65	55	60.7	7.00	4.30	7	7	100.0	0	00.0
Total						19,655	13,318	67.76	6,337	32.24

the time of the female flight be counted from sunset instead of by the clock, the maximum flight will be found to come on the average 30 minutes after it becomes dark enough for the light to attract, while in the chart it is spread over an interval of an hour and a quarter, from 7.15 to 8.30.

As a practical application of these facts it can be seen that a trap lantern run from dusk until say 10.00 p. m., an average of three hours, will capture over 60 per cent of the female moths that would be taken in the entire night at an expense for fuel or current of about one-third what it would cost to run the lights throughout the night. These observations also explain the apparent discrepancy between the statements of observers as to the sex of moths coming to light, for it is clear

that a much larger proportion of females will be taken in collections made during the evening and early night than will appear in the material taken by a trap light run all night.

In Chart A are tabulated the data obtained as to the effect of temperature on the flight of these moths. We do not know what meterological condition determines their attraction to light but we have

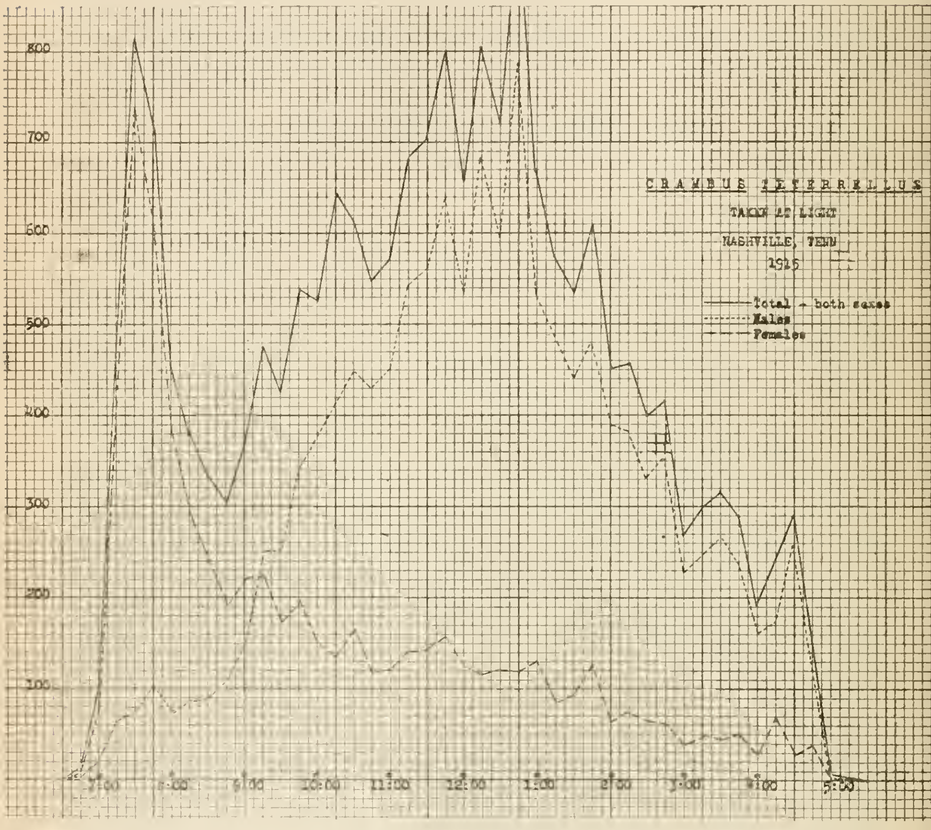

Fig. 2, Chart B. Total collections for 1915, arranged by hours of collection.

repeatedly noticed that it does not depend on temperature. If the records listed in Chart A be ranked in order by the mean temperature for the night it will quickly be seen that there is no correlation whatever between the temperature and the number of moths taken. We have several times observed two successive nights closely similar as to temperature and weather conditions, on one of which the moths swarmed at lights and on the other, few or none appeared, although

a little search with a flash lamp showed the moths to be present and even flying about over the lawn within a few feet of lighted windows. Neither does the humidity seem to bear any relation to the attraction to light. It has been suggested that barometric pressure may be

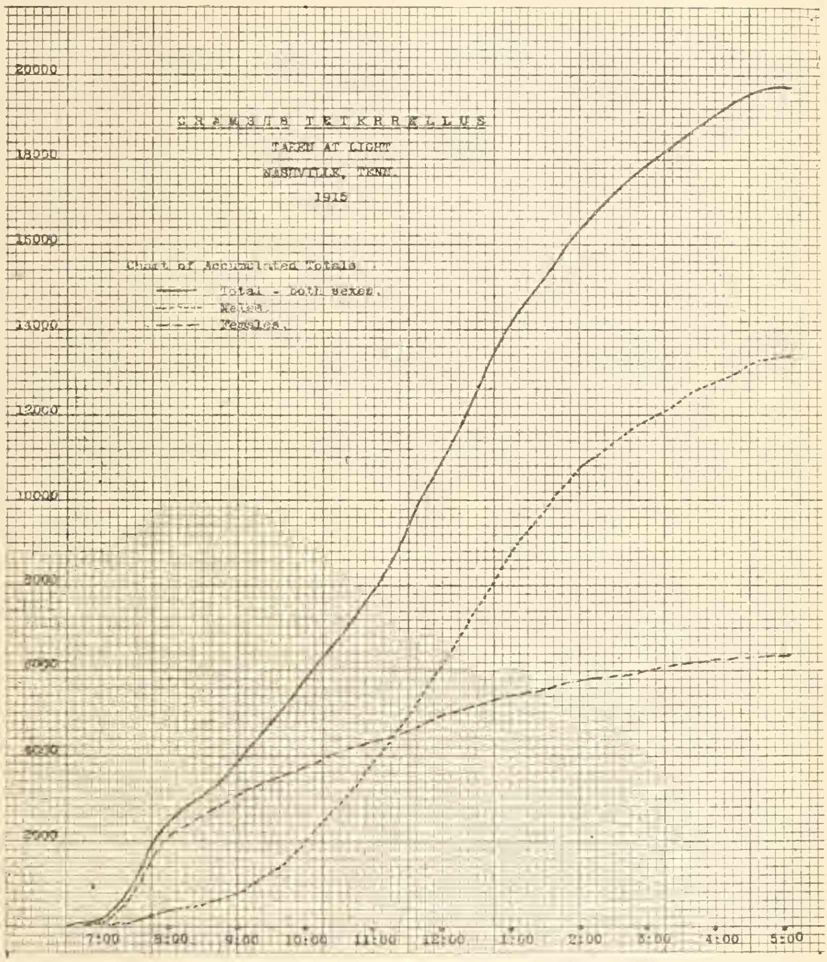

Fig. 3, Chart C. Accumulated totals of collections for 1915, arranged by hours of collection.

correlated, but no records of that were kept in connection with these collections.

The next question that arises is as to the condition of the ovaries of the females that come to light. It is assumed that the capture of the male moths is of no importance for there is little doubt, but that

the males are polygamous and their number is always sufficient to provide for the fertilization of all the females. Mating as a rule takes place very shortly after the emergence of the females from the pupa and almost invariably before they come to light, for of the large number of females taken at light and confined, a practically negligible number failed to produce fertile eggs.

Dissections of ovaries of females of several species including *teterrellus* have shown that at the time of emergence of the moth from the pupa each of the eight ovarian tubes contains about ten fully formed eggs ready for fertilization and about twenty-five more in process of development. Leaving out of account the fact that, with some species, more egg cells may and undoubtedly do develop as the mature eggs are voided, the number of theoretically possible eggs from one female of this species is about two hundred and eighty. This is well borne out by actual records. The largest number of eggs recorded from one female of this species is 323, these from a moth reared and mated in captivity. They were laid at the following rate: 132 the second day after emergence, then successively 79, 50, 43, 17 and 2, the moth dying the eighth day after emergence. The largest number of eggs secured from a moth taken in the field was 268, the largest number from a moth taken at light 250, this number being obtained from a moth taken in copula at a lighted window. From the great number of individual records of egg-laying moths it is concluded that a moth laying 200 or more eggs in confinement has not laid before the evening of capture, and is therefore practically a fresh moth. Of 76 moths taken in the field whose detailed egg records were kept, 16, or 21 per cent, laid over 200 eggs each after capture. Of 179 moths taken at light at various times throughout the season, only 8, or 4.5 per cent, laid over 200 eggs each. The average number of eggs obtained from the 76 moths taken in the open field was 117, of the 179 moths taken at light, 69. These figures all unite in pointing to the conclusion that moths of this species usually have laid a large part of their normal number of eggs, probably about 75 per cent, before they are attracted to light.

Do these moths, especially the females, feed after emergence and can they be attracted to a poisoned bait? This point was tested by several experiments conducted in different ways but along the same general lines. As the results are very similar it will suffice to give the details of one. Seventy-five female moths taken on one evening at light were placed individually in 2-ounce tin salve boxes in three sets. The boxes of set A were left empty and dry, those of set B were supplied with a small wad of absorbent cotton fastened to the inside of the cover with a drop of melted paraffin and kept saturated with water,

Chart D. Detailed Data Arranged by Time of Capture Showing Relation of the Sexes

Time	Total Moths				Males				Females			
Period Ending	Total Moths	% of Total Moths	Accumulated Totals		Total Moths	% of Male Moths	Accumulated Totals		Total Moths	% of Female Moths	Accumulated Totals	
			Moths	Per cent			Moths	Per cent			Moths	Per cent
6.45	12	.06	12	.06	3	.02	3	.02	9	.14	9	.14
7.00	96	.48	108	.54	19	.14	22	.16	77	1.21	86	1.35
7.15	373	1.90	481	2.44	67	.50	89	.66	306	4.83	392	6.18
7.30	813	4.23	1,294	6.67	74	.56	163	1.22	739	11.66	1,131	17.84
7.45	715	3.63	2,009	10.30	105	.79	268	2.01	610	9.62	1,741	27.46
8.00	452	2.30	2,461	12.60	73	.55	341	2.56	379	5.98	2,120	33.44
8.15	378	1.92	2,839	14.52	88	.66	429	3.22	290	4.58	2,410	38.02
8.30	332	1.68	3,171	16.20	91	.68	520	3.90	241	3.79	2,651	41.81
8.45	305	1.55	3,476	17.75	111	.83	631	4.73	194	3.06	2,845	44.87
9.00	370	1.88	3,846	19.63	150	1.13	781	5.86	220	3.47	3,065	48.34
9.15	478	2.43	4,324	22.06	253	1.90	1,034	7.76	225	3.55	3,290	51.89
9.30	426	2.17	4,750	24.23	253	1.90	1,287	9.66	173	2.73	3,463	54.62
9.45	539	2.74	5,289	26.97	343	2.58	1,630	12.24	196	3.09	3,659	57.71
10.00	527	2.68	5,816	29.65	376	2.82	2,006	15.06	151	2.38	3,810	60.09
10.15	643	3.27	6,459	32.92	509	3.82	2,515	18.88	134	2.11	3,944	62.20
10.30	616	3.13	7,075	36.05	451	3.39	2,966	22.27	165	2.60	4,109	64.80
10.45	547	2.78	7,622	38.83	431	3.24	3,397	25.51	116	1.83	4,225	66.63
11.00	573	2.91	8,195	41.74	452	3.39	3,849	28.90	121	1.91	4,346	68.54
11.15	684	3.48	8,879	45.22	544	4.09	4,393	32.99	140	2.20	4,486	70.74
11.30	704	3.58	9,583	48.80	561	4.21	4,954	37.20	143	2.25	4,629	72.99
11.45	802	4.08	10,385	52.88	643	4.83	5,597	42.03	159	2.51	4,788	75.50
12.00	658	3.35	11,043	56.23	533	4.00	6,130	46.03	125	1.97	4,913	77.47
12.15	804	4.09	11,847	60.32	688	5.16	6,818	51.19	116	1.83	5,029	79.30
12.30	720	3.67	12,567	63.99	597	4.48	7,415	55.67	123	1.94	5,152	81.24
12.45	908	4.62	13,475	68.61	789	5.92	8,204	61.59	119	1.88	5,271	83.12
1.00	669	3.39	14,144	72.00	536	4.03	8,740	65.62	133	2.10	5,404	85.22
1.15	575	2.93	14,719	74.93	489	3.67	9,229	69.29	86	1.36	5,490	86.58
1.30	535	2.72	15,254	77.65	442	3.32	9,671	72.61	93	1.57	5,583	88.15
1.45	611	3.10	15,865	80.75	485	3.64	10,156	76.25	126	1.99	5,709	90.14
2.00	453	2.30	16,318	83.05	389	2.92	10,545	79.17	64	1.01	5,773	91.15
2.15	459	2.33	16,777	85.38	384	2.88	10,929	82.05	75	1.18	5,848	92.33
2.30	399	2.03	17,176	87.41	332	2.49	11,261	84.54	67	1.06	5,915	93.39
2.45	419	2.13	17,595	89.54	357	2.68	11,618	87.22	62	.98	5,977	94.37
3.00	270	1.37	17,865	90.91	230	1.73	11,848	88.95	40	.62	6,017	94.99
3.15	299	1.52	18,164	92.43	250	1.88	12,098	90.83	49	.76	6,066	95.75
3.30	317	1.61	18,481	94.04	270	2.03	12,368	92.86	47	.73	6,113	96.48
3.45	290	1.48	18,771	95.52	239	1.79	12,607	94.65	51	.80	6,164	97.28
4.00	194	.98	18,965	96.50	164	1.23	12,771	95.88	30	.47	6,194	97.75
4.15	248	1.26	19,213	97.76	178	1.34	12,949	97.22	70	1.10	6,264	98.85
4.30	292	1.48	19,505	99.24	263	1.98	13,212	99.20	29	.46	6,293	99.31
4.45	143	.72	19,648	99.96	102	.77	13,314	99.97	41	.64	6,334	99.95
5.00	5	.03	19,653	99.99	3	.02	13,317	99.99	2	.03	6,336	99.98
5.15	2	.01	19,655	100.00	1	.01	13,318	100 00	1	.02	6,337	100.00
Totals	19,655	100.00			13,318	100.00	67.76% of total moths		6,337	100.00	32.24% of total moths	

those of set C the same as those of B except that dilute honey was used instead of water. Thus the 25 moths of set A had no sustenance whatever, those of set B had water, and those of set C dilute honey for food. Chart E puts the result of this experiment in compact form. It will be seen that the moths of set A were out of the running from the start as they lived a total of but 37 moth-days, laid but 59 eggs each on the

Chart E. Longevity and Fecundity of the Moths as Related to their Food Supply

	Group A Nothing			Group B Water			Group C Honey		
	Eggs	Moths		Eggs	Moths		Eggs	Moths	
		Dead	Alive		Dead	Alive		Dead	Alive
July 31	1,348	4	21	855	1	24	939	0	25
Aug. 1	97	9	12	1,200	3	21	1,634	0	25
2	20	9	3	952	2	19	856	2	23
3	12	2	1	741	5	14	502	8	15
4	0	1	0	270	3	11	180	7	8
5	..	..	..	85	3	8	4	3	5
6				54	1	7	28	3	2
7				29	2	5	4	1	1
8				26	3	2	43	1	0
9				39	0	2	..	..	..
10				26	0	2			
11				21	1	1			
12				0	0	1			
13				0	1	0			
				..	..	..			

	Group A	Group B	Group C
Total eggs	1,477	4,298	4,190
Average eggs per moth	59	172	168
Total moth-days	37	117	104
Average eggs per moth-day	39.9	36.7	40.3

average, or 39.9 per moth-day. A moth-day is the life of one moth for one day. Sets B and C were much more nearly tied and, except for the fact that many and varied repetitions of the test bore them out, the results could hardly be considered conclusive. The moths of set B, with water only, lived 117 moth-days, averaged 172 eggs per moth, or 36.7 eggs per moth-day. Those of set C with both food and drink in the form of dilute honey lived 104 moth-days, averaged 168 eggs per moth, or 40.3 eggs per moth-day. Thus it is seen that the moths with water only exceeded either of the other two sets in longevity and in number of eggs produced. Other experiments resulted in even greater superiority for the water-fed moths over those supplied with honey. A similar test using ten males in each set resulted in 10 moth-days for set A, 72 for set B and 43 for set C.

Comparative dissections of newly emerged and spent moths show

that the abundant fat masses present in the former have completely disappeared in the latter and indicate that the moths are entirely self-sustaining, being dependent on outside food neither for bodily energy nor for the development of the immature ova present when they emerge from the pupa. Aside from an occasional individual accidentally present we have never taken Crambid moths at sugar or molasses put out for insect bait. In view of these facts it is practically certain that if the moths feed at all, it is only on dew or rain drops and that sweetened sprays would not attract them in the least from their normal menu.

We are forced to the conclusion that so far, at least, as this species is concerned, and very probably with all Crambids, neither trap lights nor poisoned baits in the form of sweetened liquids can be used successfully under normal conditions to reduce the number of these very common and secretly injurious insects. While the results as applied to them are largely negative, several new and perhaps more widely useful facts have been obtained in the course of the work and are herein presented for use by others.

Mr. E. O. G. Kelly: I would like to ask Mr. Ainslee if he has any data relative to the height of the light trap.

Mr. G. G. Ainslee: I have not. I made no experiments along that line. Our moths were not taken at light traps but at house windows where they were observed to be abundant.

President C. Gordon Hewitt: If there is no further discussion, we will now adjourn.

Adjournment.

Morning Session, Saturday, December 30, 1916, 9.40 a. m.

President C. Gordon Hewitt: I declare this meeting open. We will listen to the first paper by Mr. George I. Reeves.

THE ALFALFA WEEVIL INVESTIGATION

By Geo. I. Reeves, *U. S. Bureau of Entomology.*

Introduction

The entrance of the alfalfa weevil into the United States was spectacular. The cotton boll weevil and the gipsy moth had shown the country what a calamity the importation of a foreign insect pest might be, and taught it to appreciate the gravity of such an attack upon a staple crop.

Alfalfa, the staple leguminous forage crop of the western half of the United States, is the oldest forage crop known to man. Its origin was probably in the birthplace of the human race and before the dawn of history it was grown by the Persians, who later carried it to Greece. It was brought to Spain by the Moors and to the New World by the Spaniards. It was introduced into our own Pacific Coast from Chili, and its culture has spread until the annual yield of each of the western states is reckoned in millions of dollars.

Alfalfa is grown where other crops cannot endure the rigors of climate, and under favorable conditions its growth is so luxuriant that insects have little effect upon it unless they attack it in swarms. That is what the alfalfa weevil does. After thousands of the adults which emerge in June and July each year have died from various causes during the summer and fall, there are still hundreds of thousands left to spend the winter in each acre of the fields, and enough of them survive to produce astonishing numbers of eggs. Thus the total number of larvæ and eggs present in a measured area of a certain typical field in 1913 was equivalent to 8,240,000 per acre on May 5 to 15,650,000 on May 14; to 22,920,000 on May 21; and to 10,410,000 on May 31, while on June 5 the number had sunk to 310,000 per acre, because the maturing of the larvæ outran the deposition of eggs.

The egg-laying begins in the dead stems which litter the ground, weeks before the spring growth of the plants commences, and in fact there are then many eggs remaining alive which were deposited the fall before. Oviposition in green stems begins with warm weather and increases until late in May and is so related to weather conditions that the supply of young larvæ is early and uniform in seasons when the growth of the alfalfa is of that character, and late and concentrated when the growth of the crop is late. In either case the alfalfa has no chance to mature a full crop. The larvæ feed upon nearly every leaf, and in the worst cases, completely stop the growth and consume nearly everything but the woody fibres of the plant. The hay must be cut green or abandoned. The feeding of the larvæ does not end with the attack upon the first crop; on the contrary, its effect is intensified by concentration upon the buds of the stubble so as to prevent the growth of the second crop.

This condition exists, not occasionally but every year, throughout most of the country where the weevil has become well established, including six counties which produced in 1909, according to the U. S. Census, over a quarter-million tons of alfalfa. It is a condition which is likely to spread wherever alfalfa is grown, since Salt Lake is the commercial and social center of a territory much greater than the State of Utah or even the Great Basin. There is still the hope that

the pest may prove less harmful in higher altitudes and latitudes, but that is scant comfort for alfalfa growers in regions threatened by its steady approach.

These are the reasons for the existence of the alfalfa weevil investigation. It was taken up by the Bureau of Entomology in 1910, and now employs five entomologists and a clerk. The equipment includes a one-room office, a four-room laboratory, and the usual instruments and supplies. The annual pay-roll is $8,390, the rent, $450, and other expenses, $1,500.

The practical results of the investigation have been to develop five methods of controlling the weevil, to discover and publish its occurrence in new territory and to study the factors which determine its spread. The practical control measures are flooding with sediment, spraying with arsenical poisons, pasturing, harrowing the stubble, and colonizing parasites. None of these methods is entirely perfected, and not all are equally valuable, but all are useful, and all are in actual use.

Flooding with Sediment

Covering the field with muddy water in early spring causes a deposit of silt over the surface of the ground, which imprisons the adults and the eggs contained in dry stems. It is an effective way of protecting the crop, but it is only possible in the undesirable condition where the irrigation system is without a settling reservoir. This condition obtains in many small systems, and it is then possible to carry the muddy spring floodwater over the fields and cover them several inches deep. This practice was first seen in a field situated in a ravine at Fort Herriman, Utah, where the creek ran along one side of the field and had overflowed and covered a portion of the field with silt and gravel. The buried portion was free from weevil injury, while the rest of the field was considerably damaged. We had no authentic history of the field and were unable to show that the mud had killed the weevils, but later an experiment which had been under unusually close observation for several months was ruined by being flooded with sediment. The Utah-Idaho Sugar Company had allowed us, with the Agricultural Experiment Station, to use a field of alfalfa at Saratoga Springs which was watered by the flow from a hot spring. A series of experiments with irrigation and cultivation at different seasons of the year had been begun in the fall and carried on throughout the winter, and careful examinations of the plats made at short intervals to determine the number and condition of the weevils present under various treatments. Some of the examinations were made at times when the ground was frozen hard and had to be dug up with pick and shovel, thawed out, dried, and sifted to find the weevils. Consequently, our

knowledge of that field was unusually complete. In April the greater part of the field was inadvertently flooded with sediment, and from that time there were too few weevils in the field to answer the purpose of the experiment, while they attacked neighboring fields as usual. Since mere submergence in water has practically no effect upon the insect at any stage, ordinary irrigation is ineffectual. Similar results can be produced by dragging a muddy field, but the effect upon the soil is disastrous. Since only a limited number of fields can be flooded in the way that I have described, its usefulness is limited to that extent. Where it can be practiced it is successful.

Spraying

Among methods of wider usefulness, spraying was one of the earliest to be considered. It was tried by the Utah Experiment Station, before the Bureau of Entomology took up the investigation, and was then reported favorably, but later discarded. It has since been further investigated and, while not yet perfected, it promises practical success.

The theory of spraying for the alfalfa weevil embraces two possibilities; namely, poisoning the old adults and new-hatched larvæ in early spring, and the full-grown larvæ and new adults in summer. Adults which have survived the winter begin to deposit eggs soon after warm weather arrives, at first confining their work to the dead stems of various sorts which litter the ground, but later ascending the green plants and ovipositing in them. Meanwhile, they feed sparingly upon the epidermis of leaves and stems and also use their beaks in preparing holes to receive the eggs. Although they consume but little tissue, they take it chiefly from the surface, and although they cease feeding after taking an amount of poison too small to produce immediate death, it causes them to cease ovipositing. It is probable that they feed also upon the dead stems. Poisoning the adults is therefore feasible and effective.

Many eggs which have been deposited unseasonably early, either in the spring or the previous fall, hatch before the main economic attack begins, and are numerous enough to constitute a separate problem. These early larvæ are easily poisoned by the same application which destroys the adults, and are prevented from hindering the more important purpose of the treatment. In these two ways, the early spraying protects the crops throughout the season, and in some measure through the following year as well, so that a successful spraying experiment sometimes renders the field unfit for similar work the next year.

The second possibility is in spraying the stubble after the first crop has been removed. It is unnecessary after a successful early spray,

and is in nearly every respect inferior to spring spraying, but in the absence of other treatment it destroys the adults and larvæ which gather upon the buds of the stubble and prevent the sprouting of the second growth.

The arsenical poisons commonly used in orchard work have been tried in various strengths and all are about equally useful. The method of application is largely a matter of convenience and economy, but there are some exceptions; for example, it seems to be necessary to use Bordeaux nozzles and consequently a greater quantity of liquid for the stubble spray in order to penetrate to the crevices around the crowns where the insects are gathered at that time. The best time for the application is determined by the weather and the convenience of the farmer rather than by the calendar. Results are best when the spraying is followed by warm, bright, quiet weather, such as produces a maximum of feeding.

The expense of the process contains a highly variable factor in the cost of labor, which depends upon the skill with which the operation is managed and the distance from which water must be hauled. It has been kept as low as 70 cents per acre, including all labor, in situations which were not especially favorable.

A possible objection that always arises when the spraying of a new crop is discussed, is the danger of poisoning the product. This has been disposed of in the present case by spraying hay which was nearly ready to cut, analyzing samples from the cocks, and feeding the hay to live stock. Without resorting to figures, the outcome may be presented by saying that the consulting chemist found less arsenic than is present in many samples of commercial baking powders. The consulting veterinarian upbraided us for running what he called a "fool experiment" in which there could not possibly be any appreciable physiological result while there might be an accidental casualty which would furnish an argument against spraying, and finally, the cows employed in the test, after a month of feeding exclusively upon poisoned hay, were so lively that it was impossible to get within kodak range for a satisfactory photograph outside the corral.

Spraying is probably a makeshift solution of this problem, and with more complete knowledge we may be able to devise a simpler process for handling the pest. At present it serves a purpose.

Pasturing

Pasturing is free from the objection just mentioned against spraying, and it has an insecticidal value. Its limitation is in the extent of the area that can be pastured economically. Ordinary pasturing greatly reduces the number of eggs which succeed in hatching from the green

stems of the field, but it is most effective when practised in the progressive or rotation form now used by many farmers. This method, which consists in dividing the field and turning all the animals into each enclosure in turn, meanwhile allowing the others to grow up, gives a greater yield of forage than the old way, and, what most interests the entomologist, permits the weevils to place their eggs at a considerable distance above the ground, where they are almost sure to be destroyed by the live stock at their next admittance to the enclosure. Experience shows that the weevils will deposit their eggs as near the ground as they are compelled, by the shortness of the growth, to do, while there is a limit to the closeness to which animals, particularly cows, can crop their pasture. Fields which have been pastured closely therefore sometimes suffer as much from the pest as do those which are unpastured, while fields pastured in rotation almost uniformly escape with little damage to the first crop and are practically free from weevils when the stock is removed after the egg laying season. Thus the first crop is without labor and the field is, without extra expense or effort, left in condition to produce later crops of hay.

Harrowing

In case neither spraying nor pasturing has been employed, the condition of the field after the removal of the first cutting is serious. All the larvæ and young weevils which made such inroads upon the first crop as to compel its cutting before maturity to prevent total loss, are then compelled to find food in the little sprouts upon the stubble. Although many become ineffective by pupation and many more by death from extreme heat, there are enough left to destroy all growth throughout the time usually occupied by the production of the second crop, which is thus a total loss. Any treatment of the field after the first cutting is a deplorable necessity, because that is the busiest time of the season, and labor and time are valuable, but if no earlier treatment has been applied it is simply a question of whether the crop is worth the cost of saving it.

Under such circumstances the insects can be destroyed and the crop protected by taking advantage of the fact that a temperature of 120° F. is fatal to the insects. This temperature is best produced by covering the surface of the field with something approaching a dust-mulch, unshaded by clods and vegetation. On a bright, warm day such a surface is heated by the sun enough to kill all stages of the weevil, and the dust kills many of those which escape the heat. If the field is not dry, the necessary temperature cannot be produced, and if it is too grassy, rocky or hard, the cost of the preliminary cultivation will be high. The tools used are the disc or spring-tooth harrow and some

kind of drag, and the cost is about $1 per acre. This is only nominally a cultural method, since in order to start the growth of the second crop, it must be followed by irrigation, which compacts the soil and this counteracts the cultivation. It is nevertheless a valuable method, and great credit is due the Utah Experiment Station for the principal share in developing it.

Parasites

Several species of parasites have been imported from Europe, and one is known to have become acclimated in Utah. This Ichneumonid, a species of Bathyplectes, was liberated in an alfalfa field near Salt Lake in 1912 and several secondary colonies have been started in neighboring localities. As high as 30 per cent of the larvæ present in midsummer were found to be parasitized, and it is possible to collect parasite cocoons for wider distribution without difficulty. Outside of the artificial colonies the parasite has spread spontaneously almost as widely, and it now occurs in this way throughout the Weber Valley, which is approximately parallel to Salt Lake Valley and from ten to thirty miles distant from it. It is still too early to say how valuable the parasites will be as a means of control, but a certain amount of usefulness is demonstrated beyond doubt, and there are great possibilities. In this connection the rapid reproduction of the weevil is a consideration. Although there is but one annual generation, one half of the beetles are females, and since the number of eggs produced by each is not far below one thousand, natural causes must destroy nearly 99.8 per cent in order merely to prevent the actual increase of the species.

Several parasites which are undoubtedly native American have been reared from the alfalfa weevil, and there is a possibility that they may sometime be useful. However useful they and the imported parasites may become, the alfalfa grower must take steps to protect his crops from the pest by one of the methods which have been described.

Spread of the Weevil

The alfalfa weevil investigation must devise new processes and adapt old ones for the control of the pest in new territory as fast as it spreads, and this necessitates a close watch of the boundaries of the infested district. It has been impossible to search the entire frontier every year, but the survey has been completed every second year, warnings have been given to the farmers and state authorities who were concerned, and preparations have been made for meeting new conditions. The weevil has now been found in three states and has entered the Pacific Slope. Scouting is the most expensive and least productive of

all the enterprises connected with the project, because it requires rapid travel over long distances during the busiest season, but it is considered inevitable. The spread of the weevil has been slow and uniform, regardless of the character of the country, whether cultivated or wild, and the evidence all indicates that it will continue so.

Methods of Spread

The means by which the alfalfa weevil travels is rendered an important question by the quarantine regulations which Montana, Oregon, Idaho, Arizona, and California adopted in the effort to exclude it from their territory. Consequently a minute study has been made of the natural locomotion of the insect, and of commercial traffic, involving the examination of wagons, freight and express cars, warehouses and stores, together with their contents. Nearly every case of the occurrence of weevils in commerce has been traced to actual contact of the commodity with infested alfalfa hay. Weevils are found in hay hauled in wagons, in certain cars of potatoes, and in clothing worn upon trains and carried in trunks. Representatives of the states mentioned, have embodied these facts in nearly unanimous recommendations for a revision of the quarantines.

Conclusion

These are the principal economic results of the alfalfa weevil investigation, based upon a large amount of technical work, some of which has been tedious in the performance and might prove so in the presentation. Interesting biological problems which have been encountered, and some of which have been solved, deserve ampler discussion than is possible here, while a volume could be written upon the executive obstacles which have been overcome.

President C. Gordon Hewitt: This paper is now open for discussion.

Mr. T. J. Headlee: Is there any evidence that the alfalfa weevil will not be able to come to the eastern part of the United States and prove as damaging here as it is in the western alfalfa growing states?

Mr. G. I. Reeves: There is no such evidence. There is evidence that in high altitudes the weevil is less destructive, and there is a possibility that in a different climate from that of Utah, the weevils would not be forced into inactivity by the heat of summer, the generations would be more or less spread out, and the feeding would continue through a larger portion of the year but be less concentrated and therefore less destructive. The work of the weevil is only disastrous when

it consumes plants faster than they can grow. A small amount of pruning is no doubt good for the plants, and if the feeding which takes place in two weeks could be distributed through three months it might be very advantageous. Mr. H. S. Smith, who studied the insect in Italy, was of the opinion that that was one of the principal factors in producing the condition in Italy along the seacoast, where the weevil is always present in considerable numbers, but is of no consequence as a pest. Its feeding is distributed through many months instead of a few weeks.

President C. Gordon Hewitt: I will now call for a paper by Mr. A. F. Burgess and Mr. E. L. Griffin.

A NEW TREE BANDING MATERIAL FOR THE CONTROL OF THE GIPSY MOTH

By A. F. Burgess and E. L. Griffin.[1]

About the year 1896, when the gipsy moth work in Massachusetts was in charge of the State Board of Agriculture, a small quantity of a product known as Raupenleim was imported from Germany to use for banding tree trunks to prevent caterpillars from reaching the foliage. The results with this material proved to be of enough value so that an attempt was made during the following year to manufacture it in a small way in this country. The material was of a greasy nature and was applied to the tree trunk with a trowel, the upper part of the band being thinner than the lower edge. The results with the substitute which was prepared in this country were not very satisfactory, particularly because the object of the work at that time was the extermination of the moth, and although banding was not very expensive, it was found that more caterpillars could be destroyed in a given area by using burlap and crushing the caterpillars that congregated beneath it.

When the gipsy moth work was resumed by the State of Massachusetts in 1905, the question of banding trees was a very important one. By that time tree tanglefoot had come into use and it was adopted as a satisfactory material for banding purposes and has since been used in large quantities throughout the infested area.

In 1909, Dr. L. O. Howard, while in Europe, secured a small order of Raupenleim from a German factory and shipped it to this country.

[1] The testing of the material was carried out by the Gipsy Moth Laboratory and field force of the Bureau of Entomology, while the analyses were made and material prepared at the Insecticide Laboratory, Bureau of Chemistry, U. S. Department of Agriculture.

It was applied to several species of trees by men working under the direction of Mr. D. M. Rogers. Bands about three inches wide were placed on the trees by using a wooden paddle similar to that with which tanglefoot is applied. The material did not give satisfaction, as it dried out in some parts of the band, and there was a decided tendency for it to run down the tree trunk when exposed to high temperature. It is probable that the difficulty experienced with this material was due to the method of application, but as it did not look promising further experiments were not continued.

In 1912, Mr. L. H. Worthley, while employed by the Bureau in making gipsy moth investigations in Europe, observed the successful use of Raupenleim in the German forests. He obtained a barrel of the material and had it shipped to the Bureau at Melrose Highlands, Mass. He also secured a sample of the gun used in applying the bands to the trees. This instrument consists of a tin cylinder, in one end of which is a small, somewhat rectangular orifice. Into the cylinder is fitted a plunger which can be forced forward in such a way as to slowly press the banding material through the orifice. To apply the banding material to a tree, it is simply necessary to place the orifice against the tree trunk, gradually forcing the material through while the operator moves slowly around the tree until he has encircled it. Experiments conducted by Mr. Worthley with this material during the summers of 1913 and 1914 indicated that it was very effective in preventing caterpillars from ascending the trees and that no injury was caused to the bark. Since the time these experiments were concluded, it has been impossible to obtain more of the German product.

An attempt was made in the winter of 1915 to procure a similar product in this country. Samples were sent to the Federal Insecticide Board and through the courtesy of Dr. J. K. Heywood, chairman of the board, the matter was investigated by Mr. C. C. McDonnell who detailed Mr. E. L. Griffin, one of his assistants in the Insecticide and Fungicide Laboratory, to make a special study of the material. At our suggestion, several samples were prepared having slightly different consistencies and these were tested during the winter in a chamber especially designed for the purpose, where different temperatures were maintained in order to determine whether the samples would remain intact if subjected to high temperature. The two best samples were selected and a quantity of the material was prepared for use in the field during the summer of 1915. Good results were secured, and at our request two tons each of the two samples were prepared and applied in the field during the spring of 1916. The purpose of using so large an amount was to make the test extensive enough so that definite conclusions could be drawn. The material was used in New Hampshire,

Applying tree banding material.

Gipsy moth caterpillars under tanglefoot band.

Massachusetts, and Connecticut on all kinds of trees and no injury to the trees resulted, and excellent results were secured. Many tests were also made by Mr. C. W. Collins and C. E. Hood of the Gipsy Moth Laboratory to determine the effect of using bands of different widths and thicknesses as well as to compare the results of these substances with other banding materials. One sample, however, proved better than the other on account of its being a little softer, which made it easier to handle in the guns when the temperature was low.

In gipsy moth work, banding is usually begun in April and many days the weather is rather cold. The sample which gave the best results contained the following materials.

(a) A high boiling neutral coal tar oil having a density of about 1.15 at 20°C.

(b) A soft coal tar pitch.

(c) Rosin oil of the grade known as first run "Kidney" oil.

(d) Ordinary commercial quick lime.

A stock mixture was first made up in large quantities as follows: A weighed quantity of the coal tar pitch was transferred to a ten-gallon steam jacketed kettle, which was equipped with a stirring arrangement operated by a motor, and heated until thin enough to run. Then twice its weight of the coal tar neutral oil was run in and the mixture well stirred, thus giving a product which could be poured and worked after it had cooled off. This will be referred to as the "Pitch-neutral oil mixture."

The quick lime was slaked with a small amount of water, so that the resultant product would be a dry powder. This was passed through a sieve having ten meshes to the inch.

The tree banding material was mixed as follows: 5 lbs. of the "pitch-neutral oil mixture," 16 lbs. of the coal tar neutral oil and 4 lbs. of slaked lime were weighed into the mixing kettle previously referred to, and the stirrer started working. When the contents had become of a uniform consistency, 20 lbs. of rosin oil were added and about ten minutes later 10 lbs. more of the coal tar neutral oil. At the end of twenty-five minutes from the time the rosin oil was added, the stirring was stopped and the material dumped into tubs. It was now rather thin and was allowed to stand for two days by which time it had set into a semi-solid cake. Two pounds of the coal tar neutral oil were stirred into each 50 lbs. of this mixture in order to give it the desired oily surface. The product was now ready for use.

The physical properties of the material can be varied through quite a large range by varying the proportions of coal tar neutral oil and "pitch-neutral oil mixture," and also by varying the amount of rosin oil and lime. The addition of more coal tar neutral oil makes the

material softer and more oily. Too much of it, however, gives a product which will not stand up under summer heat. A harder product can be made by the addition of more pitch or larger quantities of rosin oil and slaked lime.

The cost of the materials used (prices paid by the Department of Agriculture in the Spring of 1916) were as follows:—The high boiling coal tar neutral oil, 45¢ per gallon (about 4.7¢ per pound) and the coal tar pitch, 11¢ per gallon (about 1.1¢ per pound). They were both obtained from the Barrett Manufacturing Company, Philadelphia, Pa. The rosin oil ("Kidney" oil) was furnished by the John A. Casey Company of New York at 36¢ per gallon (about 4.32¢ per pound). The quick lime cost 65¢ per barrel of 200 lbs. (about 0.33¢ per pound). Based upon these figures the tree banding material cost 4.14¢ per pound distributed as follows: Pitch 0.03¢, Rosin oil 1.49¢, Coal tar neutral oil 2.60¢, and Lime 0.02¢. These prices do not include containers. Metal containers with bail and cover, holding 25 pounds and strong enough to bear shipment without crating will cost about 25¢ each. If the material were packed in barrels the additional cost per pound would be very small.

It is possible that a cheaper commercial coal tar distillate, such as road oil, might be substituted for the comparatively expensive coal tar neutral oil, thus bringing the cost of the material even lower.

It is evident that this material is considerably cheaper than any successful banding material that is now on the market. Pound for pound, the tree banding material will cover about two-thirds as many lineal feet as tree tanglefoot, but as the trees do not have to be scraped before applying the former band, the labor is reduced so that a large saving is made by using this material. The bands remain on the trees during the winter and can be moistened with turpentine in the spring so that they will be effctive for two seasons.

President C. Gordon Hewitt: The paper is now open for discussion.

Mr. W. E. Hinds: I would like to ask whether on highways where dust is abundant the effectiveness of the bands is reduced?

Mr. A. F. Burgess: The effectiveness of these bands is not reduced as much as in the case of tanglefoot bands, but they require more attention when there is an abundance of dust.

Mr. P. J. Parrott: I would like to ask if any allowance has to be made for high temperature as summer advances, or for excessive precipitation.

Mr. A. F. Burgess: No.

Mr. P. J. Parrott: We have been working on a preparation manufactured in this country for the purpose of preventing ants from carrying aphids on apple trees. One of the great defects in the material is that during seasons when rainfall is heavy, as in 1916, the ants were able to cross the bands after heavy rains.

Mr. A. F. Burgess: It is very difficult to secure a banding material which will not run when exposed to high temperature or harden after a rain. We have not had these difficulties with this material. It is more greasy than sticky.

President C. Gordon Hewitt: I will now call on Mr. E. D. Ball to present his paper.

EFFICIENCY AND ECONOMY IN GRASSHOPPER CONTROL

By E. D. Ball, *State Entomologist, Madison, Wis.*

That grasshopper outbreaks can be successfully controlled is a definitely established fact. That they will ordinarily be controlled under every day farm conditions is still very doubtful.

Where organized campaigns are waged against large outbreaks, public sentiment aroused, poisonous material supplied in carload lots, and distributed to those needing it, it will always be easy to obtain a high percentage of effort and a still higher percentage of efficiency. Whether the material is sold or furnished free makes little difference, so long as it is readily available and sufficient publicity has been given to arouse interest to the point of action.

Under ordinary farm conditions the handling of an outbreak is quite a different matter. The danger of damage is often realized, but the material for destruction is not at hand and often difficult to procure. The writer has several times been in communities in which it was found practically impossible to procure any strong smelling molasses,—either West India or Sugar Beet, without which the effectiveness of the poison bait is much reduced.

The Hopperdozer as usually built and operated is not very efficient and requires tar or crude oil, neither of which may be available, though kerosene may be used as an expensive substitute. Its operation in any case is disagreeable and a constant expense, and the machine is so offensive that it is almost always left outside to rust or rot.

The grasshopper catching machine is the easiest solution of many of these problems. It is efficient, inexpensive and when once built is always ready for immediate use. Communities that have once been supplied with grasshopper machines rarely call for additional help.

The first cost of a machine is less than the cost of treating forty acres with poison once, and the same publicity that will arouse a community to action in the line of poisoning mixtures will get the machines built.

The cost of treating one hundred acres by each method, using average fluctuations in prices previous to the war, will give a better idea of the problem.

Cost of Application of Poison Bran Mash Per 100 Acres

	Low	High
500 lbs. bran @ $20–$25 per ton	$5.00	$6.25
20 lbs. Paris green @ 30¢		6.00
or 20 lbs. white arsenic @ 10¢	2.00	
12 gal. molasses	6.00	12.00
10 doz. oranges and lemons	2.50	4.00
Total cost of material	$15.50	$28.25
Labor, mixing and sowing 5 days @ $2–$2.50	10.00	12.50
Total cost of treatment	$25.50	$40.75
Cost per acre—one application	.25	.40

Cost of Machine and Operation on 100 Acres

	Low	High
15 sheets tin, 20 x 30, @ 20–25¢	$3.00	$3.75
64 sq. ft. wire netting @ 3–5¢	2.00	3.20
80 ft. of inch lumber @ $20–$40	1.60	3.20
32 board ft. of 2 x 4 @ $25	.80	.85
Nails, bolts, hinges, catches, etc.	.60	1.00
Total cost of material	$8.00	$12.00
Labor, building	3.00	6.00
Total cost of machine	$11.00	$18.00
$2\frac{1}{2}$ days—man and team running machine	9.00	12.00
	$20.00	$30.00
Cost per acre	.20	.30
Cost per acre (later treatment)	.09	.12

From these tables it will be seen that the cost of one application of poison bait will vary from 25 to 40 cents per acre, while the cost of a machine for the same acreage would only amount to 20 to 30 cents per acre, and you would *have the machine* left for future use, so that later treatments would only cost from 9 to 12 cents per acre, where poison bait would cost from 25 to 40 cents.

Studying these tables from the standpoint of cash outlay, which is often of great importance to the farmer, it will be seen that the treatment of 100 acres by poison would require a cash outlay of from $15.50

to $28.25 while the total cash outlay necessary for a machine would be from $8 to $12. Even this amount could be materially reduced by using material at hand for the frame of the machine and oilcloth in place of the tin. The writer in an emergency case once built one of these machines in four hours and constructed it entirely from waste material found in the farmer's yard.

The relative efficiency of the two methods is probably about the same. There are weather conditions in which poisoning is difficult—winds and frequent showers among the worst. There are other conditions in which the machine is not successful—extremely hot days and

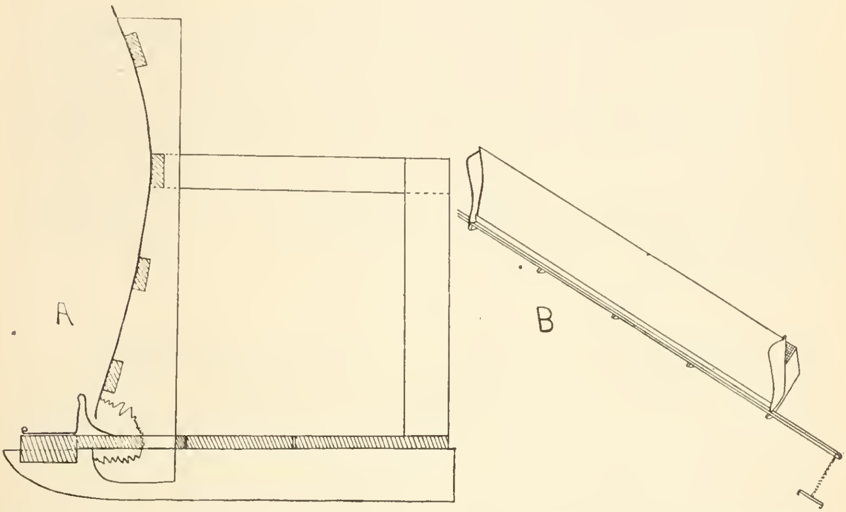

Fig. 4. *A*. An end view of the grasshopper machine showing construction. (Front upright cut out to show curve of catching device.) *B*. Front view (reduced) to show attachment of runners and horses.

windy nights, for example. In general, poisoning is most successful on warm, bright days; while the machine works best on cool mornings and cool, dark days.

A combination of the two methods is the ideal arrangement; using the poison bait along fences and ditches or on crops like tomatoes, beans and corn that will not stand the machine. The machine taking twenty-four feet at a sweep will cover forty acres per day and can thus take care of a large acreage very cheaply. On such crops as alfalfa, sugar beets, timothy and grain, before flowering time, it can be used without danger. By leaving two or three strips in a meadow when mowing, all the grasshoppers will gather on these and the machine will pick them up at a very rapid rate, thus saving the migration into other crops which so often occurs.

The construction of the machine is simple and the exact size and proportion relatively unimportant.[1] A box two feet square and sixteen feet long with a tight floor, the top and back of wire screen, with three strips in front to which are tacked 30-inch tin sheets two inches from the floor, is the ordinary form. The important thing is the construction of the catching device. The latest and best models have a low, false front, a narrow throat and an evenly curved apron which will carry the grasshoppers well into the box, as shown in Figure 4. The top is hinged in sections so that the hoppers can be shoveled out into sacks, dried and used as feed for chickens; thus changing a potential loss into a profitable feed.

The real value of the grasshopper machine is, however, as much in its availability on a moment's notice as in its economy of operation. Efficiency in insect control is founded upon promptness and effectiveness. Grasshoppers should never be allowed to reach the stage where they are threatening a crop, but crops will be threatened for a long time to come—yes, and destroyed, too—unless the future recommendations of entomologists take into consideration the probable availability of different treatments and provide for the possibilities of immediate application.

President C. Gordon Hewitt: Is there any discussion?

Mr. T. J. Headlee: How long has this machine been in operation?

Mr. E. D. Ball: This machine has no inventor as far as I know. I found it in successful operation in Colorado in 1900 and they credited it to a man from Illinois. The machine they used had a curved front with a straight piece of tin in front of it at the bottom. This allowed the grasshoppers to slide straight down onto the bottom and jump right back out. In building the later machines the front was made double with the back curved so that the hoppers slid well back into the box. As originally built, it had trap doors along the back through which it could be emptied into a trench. Some enterprising man discovered that grasshoppers were good chicken feed. We then made the machines with the trap doors along the top from which the grasshoppers were shoveled into sacks.

Mr. T. J. Headlee: Then you sack them up alive?

Mr. E. D. Ball: Yes, sir. We use nothing at all. That is the beauty of the machine—easy to build, and costs nothing to operate. I have seen two small boys—in most places in Utah they have plenty of small boys—go out in the early morning and sack up forty bushels of grasshoppers in a few hours.

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[1] Details of construction are given in Bulletin 138 of the Utah Agricultural Experiment Station.

President C. Gordon Hewitt: I will now call on Mr. Kelly to read his paper.

THE TOXOPTERA OUTBREAK IN 1916

By E. O. G. Kelly, *Bureau of Entomology, Wellington, Kan.*

(Withdrawn for publication elsewhere)

President C. Gordon Hewitt: Is there any discussion?

Mr. T. J. Headlee: I want to ask Mr. Kelly what evidence he has that the artificial introduction of parasites has accomplished little?

Mr. E. O. G. Kelly: I think the evidence was in the total destruction of all those fields into which parasites were introduced.

Mr. T. J. Headlee: That is like the chinch bug fungus. Its artificial introduction is apparently useless. Why is it not practical to kill the green-bug with spray?

Mr. E. O. G. Kelly: It might in ordinary years be all right to kill them with a spray. I indicated in my paper that Mr. McColloch arrived in Wellington on the 30th of April at which time *Toxoptera* was scarce. On the 15th of May, just fifteen days later, there were several hundred thousand acres of oats devastated in that locality, as I believe Mr. McColloch can corroborate. It would be impossible to get spraying material and machines into action to cover the territory where the pests spread so rapidly. It was just like a fire starting in a dry heap. Nothing could stop it.

Mr. G. A. Dean: It might be of interest to know that at Bedford where these parasites were taken, they occurred in enormous numbers. In one field covering a considerable area, they were present by millions, far beyond a number any one could think of introducing. Just across the road, there was a field in which *Toxoptera* had totally destroyed the greater part of the grain.

President C. Gordon Hewitt: I will now call for the paper by Mr. W. J. Phillips.

REPORT ON ISOSOMA INVESTIGATIONS

By W. J. Phillips, *Entomological Assistant, Cereal and Forage Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.*

The Division of Cereal and Forage Insects of the Bureau of Entomology began to gather data on the species of *Isosoma* infesting grains and grasses in 1904. From 1904 to 1906 inclusive, collections of mature infested grain and grass stems were made in most of the states east of

the Rocky Mountains, and a large amount of material was reared from these collections. From data thus secured it became evident that in order to establish definitely the identity and economic status of a species a large amount of careful and accurate breeding under control conditions would be necessary. Little was accomplished along these lines until 1912, since which time the writer has secured a large amount of valuable data on this most interesting and difficult group. These observations throw a flood of light on the economic importance of the *Isosoma* or joint worms, and clearly indicate that *I. tritici* is one of the most important pests of wheat in the Eastern States. The average farmer often confuses it with the Hessian fly, since the writer has had farmers tell him repeatedly that Hessian fly was injuring their wheat and upon examination it proved to be *I. tritici*. If wheat is badly straw-fallen before harvest, the farmer usually attributes the damage to the fly without examination.

Successful breeding of the many species of *Isosoma* in confinement is accomplished only under the most trying difficulties. A number of different types of cages have been tried, with varying degrees of success. There are two cages that have given fairly good results, though they are by no means perfect. One (Pl. 8, figs. 1, 2 and 4) consists of a wooden frame 3 feet square by 4 feet tall, two sides of which consist of a stout sash fitted with four large panes of glass. One of these sides is a hinged door the full size of the sash. The three other sides are covered with the best grade of cheese-cloth on the inside and $\frac{3}{8}$-inch mesh galvanized iron wire on the outside, to prevent the cloth being torn. The other cage (Pl. 8, fig. 3) consists of glass cylinders 9 x 15 inches and 11 x 24 inches, respectively, with cheese-cloth cover over the top. Plants are potted in 10-inch and 12-inch flower pots and the cylinders placed over them. These cylinder cages should be shaded.

One of the greatest difficulties in breeding *Isosoma* arises from the fact that the plants must mature, and it seems very difficult to provide normal growing conditions for the plant and, at the same time, confine these tiny insects. Aphids also greatly complicate the situation and in spite of the utmost care some will gain entrance and in a short time threaten the life of the plants. Furthermore, the *Isosoma* are constantly disturbed by the aphids and do not succeed in ovipositing. With two exceptions the different species have but one generation a year, therefore, should misfortune overtake some of the cages, a whole year is lost.

There are eighteen species of *Isosoma* occurring east of the Mississippi river, seventeen of which the writer has reared in confinement from adult to adult, and has thus learned some of the main facts

concerning their life history. The other species has refused to breed. Other members of the Division have, from time to time, sent infested grass stems from various points in the Western States, from which additional species have been reared. Strange as it may seem none of the strictly western species will breed in confinement here in the East, though repeated attempts have been made to rear some of them. On the other hand, *I. tritici*, which is the most economically important species in the East, has not been found in the great wheat belt of the West. No satisfactory solution of this problem has as yet been worked out. When this is done it may offer valuable suggestions for the control of the species here in the East. There are twenty-three distinctly recognizable species known to the writer at present, occurring throughout the United States, 5 of which appear to be strictly western species, 12 strictly eastern and 6 that overlap. There are undoubtedly a large number of new species among these, but no attempt has as yet been made to describe and name them, nor will this be attempted until a critical examination has been made of all types of American species.

Quite a striking illustration of what may be a new species is one that the writer has had under observation since 1912, having reared it from wheat stubble collected in Pennsylvania, New York, Ohio and Michigan. This species has been reared only from galls in the leaf-sheath surrounding heads of wheat, and there are occasionally root-like growths from the base of the gall downward (See Pl. 9, fig. 2). The head is always empty, no grain ever developing in plants thus attacked. The late Prof. F. M. Webster has repeatedly described to the writer the root-like projections he often used to find at the base of some galls. At that time he supposed these galls to be the result of the work of *I. tritici*. In 1903 Professor Webster published a paper [1] on *Isosoma* or joint worms and illustrates injury to a wheat plant that closely resembles the work of the species in question, though he used this to illustrate the work of *I. grande*.

This new type of gall is clearly represented on the front page of Bulletin 226, published in 1911 by the Ohio Agricultural Experiment Station, although it was intended to illustrate the work of *I. tritici*. The plant is affected in an entirely different manner by *I. tritici* (Pl. 9, fig. 3), and the two species also differ both structurally and in their life-histories. *I. tritici* pupates in the fall, males occur in abundance, and the galls are always in the wall of the stem; the former species pupates in the spring, no males having occurred in three years continuous rearing, and the galls always occur in the leaf-sheath surrounding the head and there are occasionally root-like

[1] U. S. Dept. Agr. Div. Ent., Bul. 42, p. 18, Fig. 5.

growths at the base of the gall. The species has undoubtedly been present in the Eastern States for many years and entomologists simply assumed that these galls were those of *I. tritici*. This is not at all strange or unusual since anyone but those very familiar with the group may easily confuse a number of the species.

Prof. R. W. Doane describes a species from Utah that forms galls in the leaf-sheath surrounding the head of wheat, as *I. vaginicolum* n. sp.[1] Upon request Professor Doane kindly sent specimens of his species and they were received just as this paper was being prepared. They agree in every structural detail with the species that occurs here in the East. The effect upon the plant, as described by Professor Doane also agrees entirely with the injury as noted here in the Eastern States.

A number of interesting facts have come to light as a result of cage breeding with individual species. One of the most important is that, up to the present, no species can be induced to breed on any other plant than its own particular host. This fact was ascertained by making repeated efforts to rear in confinement a given species in plants other than its own host. Before this could be attempted, however, sufficient breeding had to be done to definitely establish the identity of a species. It seems now to be a definitely established fact that the three species occurring in wheat cannot be induced to breed in any other plant. The same is true of those occurring in rye and barley, and on down the list. This is a very important economic fact, since it simplifies greatly measures for control.

Elymus species is by far the most favored host with *Isosoma*, from which no less than seven species have been reared. Wheat and Agropyron sp. come next with three species each; rye and blue-grass (*Poa pratensis*) follow with two each; barley, timothy (*Phleum pratense*), orchard grass (*Dactylis glomerata*), *Poa* sp., *Festuca* sp., and *Bromus* sp., have a species of *Isosoma* common to each.

The list just mentioned contains new species and may not and very probably does not include all species that have been previously described from this country. Some species that were very common years ago are almost extinct today, as seems to be the case with *I. hordei*. This species was evidently very numerous and destructive many years ago in the barley growing sections of the East, and today it has almost or quite entirely disappeared from these localities. This seems to be directly traceable to the greatly decreased acreage of barley over a large part of this territory. This is also probably true for the species occurring in rye. Whenever a certain grain crop ceases to be grown consecutively in contiguous fields, the future of the species

[1] Jour. of Econ. Ent., vol. IX, No. 4.

infesting the crop becomes seriously threatened. Heretofore it has been generally accepted as a fact that the different species of *Isosoma* infesting the small grains could and did infest the wild grasses. All evidence now shows that if a species of *Isosoma* is to maintain its existence, it must be supplied continually with its own particular host. Therefore, when planning control measures in the future for a particular grain-infesting *Isosoma,* we do not need to concern ourselves about the presence or absence of any other grain or grass crop or any of the wild grasses.

Oviposition of *Isosoma* is an interesting operation from many points of view. In the first place, the position the insect assumes in relation to the stem at the time of oviposition clearly indicates whether it is a gall-forming species or one that inhabits the center of the stem. The gall-forming species always takes a position facing downward (See Pl. 9, figs. 5 and 6) while those inhabiting the center of the stem always face upward when ovipositing. *I. tritici,* a gall-forming species, inserts its ovipositor almost parallel to the long axis of the plant stem instead of perpendicular as would appear from external observations. Three to five minutes are required to deposit one egg by this species. The ovipositor is then almost withdrawn and reinserted in a different channel. This performance may be repeated until seven or eight eggs have been deposited without the ovipositor ever having been entirely withdrawn from the original point of entrance, and the entire operation may require as long as thirty to forty minutes, or even longer. The individual may then proceed to the opposite side of the stem and insert several more eggs. Occasionally there may be two individuals ovipositing within a quarter of an inch of each other. As compared with the gall-forming species, *I. grande,* form *grande,* a species occupying the center of the stem, inserts its ovipositor almost at right angles to the stem, the egg often being placed within the cavity. This species requires three to six minutes to complete oviposition, then withdraws her ovipositor entirely and usually goes to another internode. *Grande,* however, does not insert more than one egg at a point, but occasionally two may be inserted in the same internode about a quarter of an inch apart, in which case one larva proceeds to destroy the other.

Isosoma tritici, when ovipositing, forces the ovipositor between the fibrovascular bundles, and the egg, which has a long petiole and a very flexible chorion, is then forced through the ovipositor in the form of a long thread. As soon as the point of the egg reaches the enlarged cavity made by the ovipositor its contents flow to that point and the egg soon begins to assume more nearly its normal shape. The petiole is then apparently gradually forced in, as the ovipositor is

slowly withdrawn, since the petiole is never found lying straight but is folded back upon itself at the end of the egg, the egg finally resting with petiole down the stem but entirely within the plant tissues. The entire egg is more slender and the petiole is much longer after oviposition. Stems have been dissected, after previously killing the female in the act of oviposition, and the position of the egg noted in relation to the ovipositor. *I. tritici* eggs require ten days to hatch, though the period of incubation varies with the temperature, cool weather retarding hatching. The larvæ molt at least three times and probably four. This can be ascertained by noting the change of shape of the larva, the development of the mouthparts and the number of cast skins, or molts. As many as three cast skins have been found in a single cell with an immature larva. The gall begins to form before the egg hatches and greatly disarranges the position of the fibrovascular bundles, which undoubtedly explains why the stems fall. From the time the larvæ are hatched until they are about two-thirds grown the tissues at the point where the galls occur and immediately above and below, are very juicy and softer than at other points along the stem and remain so until the larvæ are about grown, when the galls become much harder and very woody. As the fibrovascular bundles are badly disarranged by the galls, the stem does not have the rigidity at this point it otherwise would have if no galls were present. The plants soon become topheavy, especially if the galls are in the basal joints, and will lodge or fall with the first wind or rain. The stems usually bend over immediately above the gall, since the galls are just above a joint and the stem is slightly more rigid at that point. These galls interfere seriously with the flow of sap and a large amount is undoubtedly intercepted and used as nourishment by the larvæ, thus impoverishing the kernels of wheat.

I. tritici larvæ require approximately three weeks to reach maturity after hatching, or a month from oviposition, the time depending largely upon the temperature. *I. grande*, form *grande*, larvæ reach maturity in less time, since they emerge later and the weather is warmer.

Twelve species have been tested and all will breed parthenogenetically; eight are normally so, producing females continuously, males rarely occurring. In fact, one species has been reared continuously through a period of three years and no males have appeared. Apparently the males are not highly thought of among the eight species just mentioned since the females never pay the slightest attention to them when they do happen to be present. The other four species are not ordinarily parthenogenetic but will reproduce in this manner, the resulting offspring always becoming males. It is very probable that all our species, could they be tested, would prove to be parthenogenetic.

Although the different species of *Isosoma* refuse to accept a substitute for their own particular host their parasites are not so conservative, several of the more important ones being very cosmopolitan in their tastes. Thus it will be seen that the majority of the *Isosoma* are of either direct or indirect economic importance, since a parasite can much more easily maintain itself where there are a number of convenient hosts available.

A long list of parasites have been reared from *Isosoma*, the majority of which are new. The life histories of only a few of these parasites have been worked out in any detail. One of the most interesting ones thus far encountered is *Eurytoma pater* n. sp. The larva is a true parasite in its early stages, the final stage being completed on plant tissue. The parasite pierces the small tender gall and places its egg on the *Isosoma* larva. When the egg hatches the host larva is about a fourth to a third grown. By the time the parasite consumes the *Isosoma* larva it is scarcely a third grown and the only alternative is for it to finish its development on plant tissue, which at that time is very soft and succulent. These larvæ do complete their development in the same *Isosoma* cell, since they seem incapable of migrating to nearby cells to prey upon other larvæ. Therefore, as stated previously, it seems that they must and do complete their development on plant tissue.

The most important parasites of *I. tritici* are undoubtedly *Ditropinotus aureoviridis* Cwfd. and *Homoporus chalcidophagus* Walsh. There are two others, *Eurytoma pater* n. sp. and *Eurytoma bolteri* Riley var. *parva* n. var., are probably next in importance. Immense numbers of *I. tritici* are killed nearly every winter by extreme cold. Another active agency in the control of *I. tritici* is a tiny mite, *Pedi-*

PLATE 8

Fig. 1. Isosoma breeding cage with door closed.
Fig. 2. Isosoma breeding cage with door open.
Fig. 3. Pot cage for Isosoma breeding.
Fig. 4. Isosoma breeding Experiments at Charlottesville, Va.

PLATE 9

Fig. 1. Sheath dissected from the head of wheat, showing the galls in the sheath and not in the stem.
Fig. 2. Shows typical galls of the species that forms galls in the sheath surrounding the heads of wheat.
Fig. 3. Typical galls of *Isosoma tritici* in wheat. Note that the galls are in the stem itself.
Fig. 4. Plants showing typical injury from the species that forms galls in the sheath surrounding the head.
Fig. 5. A gall-forming *Isosoma* inserting ovipositor.
Fig. 6. A gall-forming *Isosoma* ovipositing.

culoides ventricosus Newport. Indeed, if it were not for the natural agencies of control the farmer would be either obliged to abandon wheat growing in the states east of the Mississippi River or adopt drastic measures of control.

One of the most promising measures of control of *I. tritici* at present in some of the Eastern States is to plow under wheat stubble as soon after harvest as is possible, prepare a fine seed bed and sow the clover and grass in August or September instead of seeding in the wheat in the spring. The writer does not have sufficient data as yet on this point to make a definite statement but it seems very promising. Liberal applications of commercial fertilizer or well-rotted barnyard manure will enable the plants to largely overcome the injury.

There seems to be little hope for beneficial results from burning the stubble. This was attempted for two winters in Indiana and at no time, when the ground was frozen, could the stubble be burned.

The writer hopes to have the opportunity this winter of making a thorough examination of the types of the various American species and will then describe any new species he may have, after which he will gladly identify *Isosoma* for anyone for the privilege of using the data and retaining any uniques or a small series of any that may belong to a new species.

President C. Gordon Hewitt: If there is no discussion, we will proceed to the next paper by Mr. G. A. Dean.

RESULTS OF TEN YEARS OF EXPERIMENTAL WHEAT SOWING TO ESCAPE THE HESSIAN FLY[1]

By Geo. A. Dean, *Entomologist of the Kansas State Agricultural College and Experiment Station*

The time that wheat should be sown to escape the fall brood of the Hessian fly and the time that it should be sown to produce the maximum yield are problems that have been and are still receiving much attention from nearly every student of these subjects. In a state like Kansas, producing an enormous wheat crop, that may equal one fifth of the production in the United States, as in 1914, and in a state

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 23. This paper embodies the results of some of the investigations in the prosecution of project No. 8, Kansas Agricultural Experiment Station. The writer desires to acknowledge the valuable assistance of J. W. McColloch, assistant entomologist, for much of the work and the careful supervision of the field experiments. He also desires to express his appreciation of the valuable services of Prof. C. E. Call and members of his staff in the Department of Agronomy.


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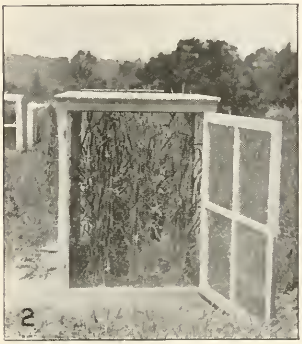
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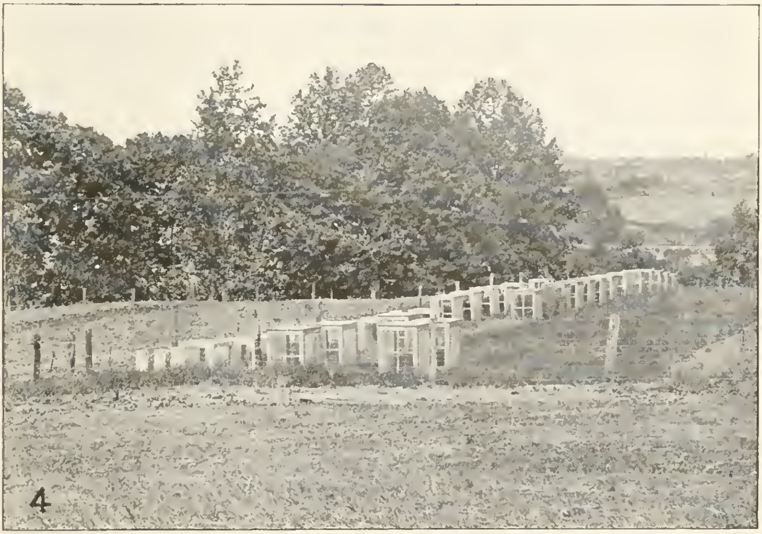
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suffering heavy losses from the Hessian fly that may reach sixteen million dollars, as in 1915, the time of seeding to produce the maximum yield and the time of seeding to escape the fly are two of the most important factors in growing wheat.

"There can be no doubt that the seasonal periodicity so characteristic of animals and plants generally is exhibited in both the Hessian fly and its host plants—that there is a period of time in the fall during which, under normal conditions of food supply, the emerging flies have the best possible opportunity to perpetuate their kind and that there is likewise a period during which wheat placed in the soil stands the best chance to produce the maximum yield. This period may be designated as the normal time of fall-brood fly emergence and the normal

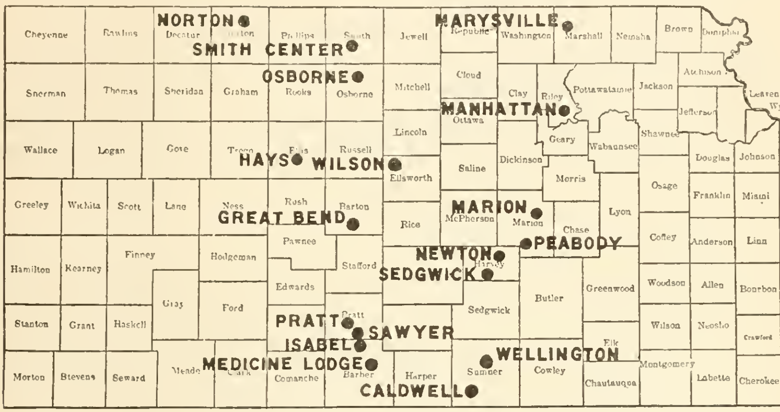

Fig. 5. Map of the state of Kansas showing stations of the last ten years.

time for wheat sowing, respectively. The problem of determining when wheat should be sown to escape the fall brood of the Hessian fly involves the explanation of the relationship existing between the normal period of fly emergence and the normal period of wheat sowing." [1]

In order to secure data bearing on the problem, a series of experimental sowing was begun in 1907 by Dr. T. J. Headlee, then entomologist of the Kansas Experiment Station. These sowings have now extended over a period of ten years, and it is planned to continue them over another period of ten years. The sowing in 1907 consisted of a single series of stations extending along the eastern edge of the wheat belt from the northern to the southern part of Kansas, but all subsequent sowings consisted of a double series of stations, one along the eastern and one along the western edge of the great central wheat belt. The individual stations of the eastern series are located from

[1] Headlee, T. J., Journ. Econ. Ent., p. 98, vol. V, No. 2, 1912.

north to south at Marysvi le, Manhattan, Marion, Peabody, Newton, Sedgwick, Wellington, and Caldwell (Fig. 5) The individual stations of the western series are located from north to south at Norton, Smith Center, Osborne, Hays, Wilson, Pratt, Sawyer, Isabel, and Medicine Lodge. Each sowing consisted of seeding a series of plots at weekly intervals for six or seven weeks, beginning the second week in September. The stations have been secured and managed coöperatively by the departments of Agronomy and Entomology of the Kansas Experiment Station. Representatives of the United States Bureau of Entomology have visited most of the stations each year, taking such data as they desired. In all cases, the ground was prepared, the seed selected and planted, and the crop harvested under the directions of the Department of Agronomy.

In summarizing the data of the experimental wheat sowings, the following conclusions may be had:

(1) Inasmuch as the best time to seed wheat to secure maximum yield varies with different sections of the state, with different seasons, and with other conditions, the proper time of seeding must be determined for each locality by experimental sowing extending over a period of years.

(2) In Northeast Kansas (Table I), the best yield in one year was obtained from seeding September 23 and in the four other years from seeding September 29 to October 11. The experiments show a very clear and definite decrease in the infestation of Hessian fly with late seeding. In one season (1914), about 50 per cent of the wheat sowed before September 20 was infested, while none sowed after the first week in October had any flies.

(3) At Manhattan (Table II), in practically all seasons, the best yields were obtained from seeding during either the fourth week in September or the first week in October. Even in several of the years when very little Hessian fly was present, there was no advantage from early seeding. This is especially true if the ground is well prepared.

(4) In East Central Kansas (Table III), the best yields have been obtained with seeding between September 29 and October 20. In the years of 1914–15 and 1915–16, the wheat sowed early was practically a total loss because of fly.

(5) In Southeast Kansas (Table IV), the sowings seem to favor rather early seeding, that is, from September 15 to September 23, as shown by the results obtained in 1913 and 1914. However, the Hessian fly caused practically no damage in these two seasons. In the seasons of 1914–15 and 1915–16, all plots sowed before October 1 were practically destroyed by the fly, and the late sown wheat produced very small yields because the fly which infested the early plots mi-

grated in the spring into the late sown plots and deposited their eggs in large numbers.

(6) In North Central Kansas (Table V), somewhat earlier seeding than for points east and south is desirable. This is because the elevation and latitude shorten the season and grain must be sowed earlier to get a good start before winter. However, the sowing tests show that, if He sian fly is abundant, the seeding should be delayed until the second week in October.

(7) In West Central Kansas (Table VI), the best yields have been secured from September seedings. Probably the best date for this section, on the average, is from September 15 to September 20. However, as in other sections of the state, if the Hessian fly is present in damaging numbers, the seeding should be delayed until October 1.

(8) In Pratt and Barber Counties (Table VII), the seeding tests show that where no flies are present, seeding earlier than September 15 gives no better yields than somewhat later seeding. When flies are present, later seeding, up to October 1 on poor soil and October 6–7 on fertile soil and a well-prepared seed-bed, will give better results than early seeding.

(9) In summarizing the time of seeding for the greater part of the wheat belt, it may be said that on an average seed-bed when Hessian fly is not present in damaging numbers, the maximum yield of wheat will be obtained in an average season by seeding a little earlier than the fly-free date (Table VIII). The better the seed-bed is prepared, the safer it is to wait until the fly-free date to sow. It should be understood that if the Hessian fly is present in damaging numbers and the wheat is seeded earlier than the fly-free date, there is a greater risk of the crop being injured by the fly and, therefore, seeding should be delayed to as near the fly-free date as is practical.

(10) "Wheat that is sowed late usually winter-kills considerably. Since the roots do not penetrate the ground so deeply as when it is sowed early, it is more subject to injury from drought and hot winds. Late sown wheat tillers very little and hence usually gives a thin stand. It ripens later and, in the eastern part of the State, is more likely to be injured by rust than wheat that is sowed somewhat earlier. The quality of late sown wheat is usually not as good as that of early sown wheat.

(11) "If the Hessian fly is present in the neighborhood, wheat that is sowed early is practically certain to be injured by the fly and, in many instances, totally destroyed. In dry seasons, very early seeding is often detrimental because the heavy growth uses all the moisture stored in the soil and leaves the crop entirely dependent on seasonal rains. This happens frequently in the western edge of the wheat belt." [1]

[1] Bul. 213, Kansas Experiment Station, 1916.

(12) It has been found that early plowing of the stubble, at least five inches deep, is not only very effective in controlling the Hessian fly, but is also very successful in promoting a rapid growth of the wheat in the fall, and for this reason wheat may be sowed considerably later on ground that has been plowed early and deep than if it has been carelessly plowed. "When ground is plowed early, plant food is developed very rapidly and water is usually stored in the soil for the growth of the plant. As a result, growth is rapid, the plants tiller abundantly, and strong roots are developed before winter. Rather late seeding on a well prepared seed-bed will give much better yields than early seeding on poorly prepared ground even when no Hessian flies are present. Also, wheat that has made a good growth is better able to resist attacks of the fly, since it tillers more and there are more stalks to take the place of those destroyed."[1]

(13) Since many of the flies migrate considerable distances, early, deep plowing, to be effective, must be practised by the entire neighborhood in such a manner as to include all infested fields, and since it is usually impractical to plow all fields in a neighborhood early and deep, the only way to insure safety from the fall brood of fly is to sow after the fly-free date.

(14) Late sowing alone will protect most of the wheat in the fall from becoming infested by the fall brood of the fly, but it should be remembered that there is also a main spring brood and, if any volunteer is growing in the main field of wheat, or in the old stubble fields left to plant to some other crop the next spring, or if there is a field of early sown wheat nearby, the spring brood of flies, emerging from the infested plants about the first of April, is very apt to infest the late sown crop, and thus wheat absolutely free from fly in the fall may become dangerously infested next spring by the spring brood (Table IX). In Kansas, in the springs of 1915 and 1916, hundreds of cases of this sort were true and it will probably always be true of any year when there is a general infestation over the whole neighborhood. The Hessian flies will migrate in dangerous numbers for several miles, hence the importance of community coöperation cannot be overemphasized. One man with a field of volunteer or with a field of early sown wheat may endanger a number of wheat fields which were free from infestation in the fall.

(15) In Kansas, the important steps in the control of the Hessian fly are: (1) early, deep plowing of the stubble; (2) the proper preparation of the seed-bed; (3) destruction of all volunteer wheat; (4) delay the sowing until the fly-free date; and (5) coöperation.

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[1] Bul. 213, Kansas Experiment Station, 1916.

TABLE I—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY IN NORTHEAST KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

	Year	Place	Date of Seeding Period										
			Sept. 1–5	Sept. 6–10	Sept. 11–15	Sept. 16–20	Sept. 21–25	Sept. 26–30	Oct. 1–5	Oct. 6–10	Oct. 11–15	Oct. 16–20	Oct. 21–25
Per cent of infestation	1907–08	Marysville				0		0		0		0	
	1908–09	"	55.4		37.2		54.3		0		0		
	1909–10	"	61.0		26.0		1.3		0	0			
	1910–11	"			3.0	0.8		0	0	0		0	
	1911–12	"			6.1	4.6	0.3		0		0		0
	1912–13	"		41.3		24.4	4.6	0.7		0	0		0
	1913–14	"		48.8	53.0		42.4	18.0		0	0	0	
	1914–15	"					12.0	10.0		0	0		0
	1915–16	"			84.2	59 2		19.5	0		0	0	
	1916–17	"				58.0	83.0		11.0	0		0	0
Bushels per acre	1911–12	Marysville			*	*	*		*26.6*		25.0		*
	1912–13	"		42.2		42.2	*45.2*	41.5		39.3	27.8		25.6
	1913–14	"		22.5	26.4		32.7	*39.1*		38.4	33.9	36.1	
	1914–15	"					29.2	*35.0*		34.2	29.4		33.1
	1915–16	"			0	17.9		26.9	26.2		*29.0*	26.9	

* Winter killed.

Table II—Per Cent of Plants Infested by the Fall Brood of Hessian Fly at Manhattan, Kansas, Together with Yields Obtained in Date of Seeding Tests

	Year	Place	Date of Seeding Period									
			Sept. 1–5	Sept. 6–10	Sept. 11–15	Sept. 16–20	Sept. 21–25	Sept. 26–30	Oct. 1–5	Oct. 6–10	Oct. 11–15	Oct. 16–20
Per cent of infestation	1907–08	Manhattan		7.7		7.3		3.3		0		0
	1908–09	"		2.2	1.0	1.8	1.7	1.4	0.6	0	0	0
	1909–10	"		0		0		0		0		0
	1910–11	"			0	0		0	0	0		0
	1911–12	"			2.0	3.5		0	0	0		0
	1912–13	"				28.7	12.2	1.8		0	0	0
	1913–14	"		24.1	21.9		9.0	0		0	0	
	1914–15	"		87.1		19.2	15.4	7.7	2.4		1.0	0
	1915–16	"		93.0	66.0		69.0	5.0	1.0		0	0
	1916–17	"			97.0	77.0		72.0		0	0	0
Bushels per acre	1907–08	Manhattan		22.5		28.5		31.5		*34.4*		32.1
	1910–11	"			44.8	50.0		*53.8*	52.8	51.2	45.7	45.0
	1911–12	"			15.0	26.8		25.4	*27.0*	14.5		6.8
	1912–13	"				41.3	44.1	*47.5*		40.3	25.1	20.0
	1913–14	"		46.2	44.5		46.5	*46.8*		44.5	36.8	22.8
	1914–15	"		0		0	17.3	21.3	26.0		*28.7*	22.7
	1915–16	"		0	0		0	16.3	*23.2*		17.1	18.5

TABLE III—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY IN EAST CENTRAL KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

	Year	Place	Date of Seeding Period										
			Sept. 1–5	Sept. 6–10	Sept. 11–15	Sept. 16–20	Sept. 21–25	Sept. 26–30	Oct. 1–5	Oct. 6–10	Oct. 11–15	Oct. 16–20	Oct. 21–25
Per cent of infestation	1907–08	Sedgwick		23.7		22.1		0			0	0	
	1908–09	"	100.0		100.0		95.2		20.3	0		0	0
	1909–10	"					0	1.1		0	0	0	
	1910–11	Marion			1.1		0	0	0		0	0	0
	1911–12	"				0.4	0		0	0		0	0
	1912–13	Peabody		4.4		0	2.1	1.0		0	0		
	1913–14	"			40.5		19.3	12.8		0	0	0	
	1914–15	Newton				54.0	66.0	31.0	16.0		3.0	0.3	
	1915–16	"				88.9		85.2	30.0		8.7	1.0	0
	1916–17	"				34.1	37.2		6.7	0		0	0
Bushels per acre	1910–11	Marion			20.3		20.3	18.9	*20.8*		20.2	16.6	14.5
	1911–12	"				*	*		*	*		*	*
	1912–13	Peabody		13.7		14.0	12.2	*16.9*		9.0	7.0		
	1913–14	"			24.1		24.4	*28.3*		14.3	12.7	11.9	
	1914–15	Newton				1.08	1.0	1.8	6.0		8.75	*11.0*	
	1915–16	"				1.04		1.41	3.32		15.18	*16.99*	16.58

* Destroyed by drought and chinch bugs.

TABLE IV—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY IN SOUTHEAST KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

	Year	Place	Date of Seeding Period										
			Sept. 1–5	Sept. 6–10	Sept. 11–15	Sept. 16–20	Sept. 21–25	Sept. 26–30	Oct. 1–5	Oct. 6–10	Oct. 11–15	Oct. 16–20	Oct. 21–25
Per cent of infestation	1907–08	Caldwell		1.3		2.4		3.0		5.1		0	0
	1908–09	"	100.0			100 0	100.0				0		0
	1909–10	"			5.6	51.7	43.1	9.9	23.0				
	1910–11	Wellington	*										
	1911–12	"			0	0	0		0	0		0	0
	1912–13	"				0	0	0		0	0		0
	1913–14	"		1.7	1.2		0.2	0		0	0	0	
	1914–15	"				100.0	95.0	35.0		15.0		0.05	0
	1915–16	"						70.7	36.4		9.5	2.4	0
	1916–17	"				7.0	1.6		0.4	1.3		0	0
Bu. per acre	1912–13	Wellington				8.4	*8.6*	6.8		2.4	1.3		0.2
	1913–14	"		30.4	*31.3*		30.8	30.7		30.3	22.5	13.1	
	1914–15	"				0.7	1.43	2.7		3.7		*4.8*	3.1
	1915–16	"						3.5	5.7		8.7	9.8	*11.2*

* No planting.

Table V—Per Cent of Plants Infested by the Fall Brood of Hessian Fly in North Central Kansas, Together With Yields Obtained in Date of Seeding Tests

	Year	Place	Date of Seeding Period									
			Sept. 1–5	Sept. 6–10	Sept. 11–15	Sept. 16–20	Sept. 21–25	Sept. 26–30	Oct. 1–5	Oct. 6–10	Oct. 11–15	Oct. 16–20
Per cent of infestation	1907-08	Norton										
	1908–09	"		0		0		0		0		0
	1909–10	"				0	0	0	0	0		0
	1910–11	Smith Center			0	0		0	0	0		0
	1911–12	" "			4.0	0.6	0		0	0 01		0
	1912–13	Osborne		0.5		0	0	0		0	0	0
	1913–14	"		0.5	2.0		0	0		0	0	0
	1914–15	"				0	0	0	0		0	0
	1915–16	"			1.0	37.7		51.9	44 0		28.5	23.0
	1916–17	"				41.0	42.0		13.0	1.0	0	0
Bushels per acre	1911–12	Smith Center			28.8	28.8	*32.2*		31.8	30.0		18.8
	1912–13	Osborne		*44.2*		35.0	33.2	32.1		29.8	27.5	24.9
	1913–14	"		21.9	21.5		*23.7*	19.0		17.3	14 1	10.6
	1914–15	"				30.6	36.7	*39.9*	36.3		31.8	36.3
	1915–16	"				15.9		16.8	31.7		*36.7*	30.9

TABLE VI—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY IN WEST CENTRAL KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

	Year	Place	Date of Seeding Period										
			Sept. 1–5	Sept. 6–10	Sept. 11–15	Sept. 16–20	Sept. 21–25	Sept. 26–30	Oct. 1–5	Oct. 6–10	Oct. 11–15	Oct. 16–20	Oct. 21–25
Per cent of infestation	1908–09	Wilson		64.0	58.0		71.0	66.0	3.0		0		
	1909–10	"			0	0		0		0			
	1910–11	"			0	0		0	0		0	0	0
	1911–12	"			0	0	0		0	0		0	0
	1912–13	"		0		0	0	0		0	0	0	
	1913–14	"		0	0		0	0		0	0	0	
	1914–15	"			0		0	0	0		0	0	
	1915–16	Hays	8.1		13.4				3.0		0		
	1916–17	"		44.0		7.0			0			0	
Bushels per acre	1911–12	Wilson			20.1	24.9	*26.0*		25.7	19.3		8.4	10.3
	1912–13	"		*17.8*		13.4	11.7	10.2		11.3	11.6	8.7	
	1913–14	"		16.5	18.0		20.0	21.9		*24.4*	22.2	20.5	
	1914–15	"			*31.9*		28.6	29.9	26.1		18.5	22.2	
	1915–16	Hays	3.01			31.5			27.7			29.7	

Table VII—Per Cent of Plants Infested by the Fall Brood of Hessian Fly in South Central Kansas, Together With Yields Obtained in Date of Seeding Tests

	Year	Place	Date of Seeding Period									
			Sept. 1–5	Sept. 6–10	Sept. 11–15	Sept. 16–20	Sept. 21–25	Sept. 26–30	Oct. 1–5	Oct. 6–10	Oct. 11–15	Oct. 16–20
Per cent of infestation	1908–09	Sawyer				56 0	100.0			0		
	1909–10	Pratt			3.2		0.5		10.4	12.3		
	1910–11	"	*									
	1911–12	"			0	0	0		0	0		0
	1912–13	"		1.8		0	0	0		0	0	0
	1913–14	Medicine Lodge					0	0		0	0	0
	1914–15	" "			0 6		0	0	0		2.2	0
	1915–16	" "	*									
	1916–17	Isabel				9.5	6.1		2.5	0		0
Bu. per acre	1911–12	Pratt			23.3	21.6	23.3		23 3	*25.0*		14.4
	1912–13	"		18.6		*25.6*	17.8	18.1		20.3	14.8	12.6
	1913–14	Medicine Lodge					*31.7*	28.6		28.5	27.8	26.5
	1914–15	" "					19.0	*21.7*	18.7		18.9	19.0
	1915–16	" "	*									

* No planting.

Table VIII—Summary of Tables I–VII, Showing Date of Maximum Yields and Date of Safe Sowing

Year	Locality													
	Northeast Kansas		Manhattan, Kansas		East Central Kansas		Southeast Kansas		North Central Kansas		West Central Kansas		South Central Kansas	
	Date of Max. Yield	Date of Safe Sowing	Date of Max Yield	Date of Safe Sowing	Date of Max. Yield	Date of Safe Sowing	Date of Max. Yield	Date of Safe Sowing	Date of Max. Yield	Date of Safe Sowing	Date of Max. Yield	Date of Safe Sowing	Date of Max. Yield	Date of Safe Sowing
1907–08		No fly	Oct. 9	Sept. 29		Sept. 26		Oct. 16						
1908–09		Oct. 5		Sept. 28		Oct. 10		Oct. 12		No fly		Oct. 5		Oct. 7
1909–10		Sept. 22		No fly		No fly		*		No fly		No fly		Oct. 18
1910–11		Sept. 19	Sept. 26	No fly	Oct. 5	No fly		†		No fly		No fly		†
1911–12	Oct. 4	Sept. 25	Oct. 3	Sept. 26		No fly		No fly	Sept. 25	Sept. 18	Sept. 25	No fly	Oct. 9	No fly
1912–13	Sept. 23	Sept. 30	Sept. 30	Sept. 30	Sept. 30	Sept. 16	Sept. 23	No fly	Sept. 9	No fly	Sept. 9	No fly	Sept. 16	No fly
1913–14	Sept. 29	Oct. 6	Sept. 29	Sept. 29	Sept. 29	Oct. 6	Sept. 15	No fly	Sept. 22	No fly	Oct. 6	No fly	Sept. 22	No fly
1914–15	Sept. 30	Oct. 7	Oct. 12	Sept. 28	Oct. 19	Oct. 12	Oct. 17	Oct. 17	Sept. 27	No fly	Sept. 14	No fly	Sept. 27	No fly
1915–16	Oct. 11	Oct. 4	Oct. 4	Oct. 4	Oct. 20	Oct. 20	Oct. 25	Oct. 18	Oct. 11	*	Sept. 17	Oct. 1		†
1916–17		Oct. 9		Oct. 6		Oct. 9		Sept. 25		Oct. 9		Oct. 2		Oct. 2

* Planting not late enough to obtain date of safe sowing. † No planting.

Table IX—Per Cent of Infestation of Hessian Fly on April 1, 1915, before the Spring Brood Had Emerged and June 1, 1915, after the Spring Brood Had Emerged at Wellington and Newton

Date of Inspection	Place	Date of Seeding Period					
		Sept. 16–17	Sept. 21–23	Sept. 27–30	Oct. 5–7	Oct. 12–17	Oct. 19–21
April 1, 1915	Wellington	100.0	0.95	34.7	15.2	0.50	0
June 1, 1915	"	100.0	100.00	100.0	100.0	100.00	100.000
April 1, 1915	Newton	54.0	66.00	31.0	16.0	0.03	0.003
June 1, 1915	"	97.0	96.00	97.0	90.0	80.00	60.000

President C. Gordon Hewitt: This paper is now open for discussion.

Mr. T. J. Headlee: I wish to inquire of the speaker how we can harmonize the data derived from the sowings at Columbus and Wooster, Ohio, with the results he has gotton in Kansas since 1912. In five out of a possible six years at Columbus and in seven out of a possible nine years at Wooster, the date of sowing for maximum yield came later than the date of fly-free sowing.

Mr. G. A. Dean: I cannot explain this, but I believe that in order to get your fly-free date and the date for maximum yield, you must establish these local stations and carry on these experiments covering a number of years. The first two or three years in Manhattan the fly-free date was not far from the time for maximum yield. Then came the years of Hessian fly outbreaks, increasing each year. For instance, the damage in 1915 amounted to fully $16,000,000 followed next year with a net loss totaling in the neighborhood of $15,000,000 or $16,000,000. It should be remembered that in Kansas we may get five broods of the Hessian fly. For instance, we have the main fall brood, the supplementary fall brood, the main spring brood, the second spring brood, and the summer brood. In a state like Kansas, with a great variation of climate and other conditions, I don't believe you can figure out the conditions from another state, for instance, Ohio, where they do not have such a great variety of climate and conditions as we do in Kansas.

Mr. A. D. Hopkins: This subject of the Hessian fly carries me back to the West Virginia work, so that I am to be pardoned for digressing from forest insects to talk about crop insects. Ever since that work was done in West Virginia, beginning in 1887, I have continued the study of the principle or law of altitude and latitude, and in recent years the factor of longitude has been introduced, which clears up the situation and enables us to indicate dates of periodical events like

theoretical fly-free dates in Kansas from determined dates in West Virginia or Ohio. Before I came to New York to attend these meetings I attended a conference on the Hessian fly at the Bureau of Entomology and presented maps and tables showing how fly-free dates could be computed for the entire winter wheat region of the United States and Canada, and that the computed or theoretical dates agreed very closely with the general dates for sowing wheat at a number of representative places in each state, as taken from the bulletin on Seed-time and Harvest.[1] In this bulletin the dates are given on which the greater number of farmers sow wheat, which is a pretty good indication as to the best time to sow wheat to give the best yield in an average season and at the same time be late enough to escape the fall attack of the fly. The computation of fly-free dates was based on Webster's average date for Columbus, Ohio, and our present law of latitude, longitude, and altitude which may be defined as follows:

All other conditions being equal the variation in the date of a periodical event in the seasonal activities of a plant or animal in North America north of Mexico is at the average rate of four days for each 1° of latitude, 5° of longitude and 400 feet of altitude—earlier southward, westward and descending in the spring and early summer and later in the reverse directions in late summer and autumn. This gave me a fly-free date of August 31 for Orono, Maine—farthest north—and November 11 for southern Texas, a difference of seventy-two days. After determining the theoretical fly-free dates for all of the intervening states, I compared them with the general dates of sowing wheat in the same section of the states and got some rather interesting results, in showing with very few exceptions that the theoretical fly-free date coincided closely with the general wheat sowing periods for all localities compared.

At Wooster, Ohio, the fly-free date is September 20 while the average time for sowing wheat is September 18 or two days earlier than the fly-free date. At Columbus, Ohio, the determined average fly-free date is September 25, and the average date of sowing wheat is September 24.

At Wellington, Kansas, the fly-free date should be October 10. Now what is your date, Mr. Dean?

Mr. G. A. Dean: October 12 or 13.

Mr. A. D. Hopkins: The theoretical date misses it only about a day. But October 3 is given as the best date to sow wheat. That agrees pretty well, doesn't it?

Mr. G. A. Dean: Yes, for maximum yields.

Mr. A. D. Hopkins: For Manhattan, Kansas, we have October 5

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[1] Covert, James R., Seed-time and Harvest, Bul. 85, Bur. Stan., 1912.

as the fly-free date and the wheat sowing date October 28. What is your fly-free date for Manhattan?

Mr. G. A. Dean: October 4.

Mr. A. D. Hopkins: Well, there too we miss it only by a day. You cannot calculate across the country much closer. These theoretical dates will approximate the actual dates and thus serve as indices to the proper date for any place in the area in which winter wheat is sown, including Canada. The law of latitude, longitude, and altitude enables us to give an approximate date for sowing wheat anywhere from southern Canada to Texas, and we will be glad to help those of you who are investigating the Hessian fly to apply this law to your local problems. If you will give me the determined fly-free date, latitude, longitude, and altitude for any place in your state, I will explain how to find the theoretical fly-free dates for any other places in the state. Then if you will take these dates as a basis for comparison with previous or subsequent records of actual fly-free dates and let me know later on what you find it will help us both, I think. There is special need of local observations on such details. Here is an opportunity to carry out, on quite an extensive scale, investigations to determine the practical value of the law as applied to the Hessian fly.

With a known date of the disappearance of the fly at the northern range of winter wheat in Canada, we would have from four to seventy-two days in which to inform the farmers in the United States when to sow wheat at places south of the Canadian base. The actual date will vary, of course, in different localities, due to local conditions, but such constant departure will indicate the intensity of the local influence and the number of plus or minus days required to connect the theoretical date. If, on the other hand, it is a seasonal variation, as that resulting from a drought, farmers can be instructed to wait until it rains before sowing wheat.

Mr. T. J. Headlee: How does longitude come in? I understand quite well the matter of altitude and latitude, but when you deal with longitude what is the factor? There is a principal factor that you measure, and following that, where do you establish your base line?

Mr. A. D. Hopkins: At any longitude. It makes no difference on what meridian you start. A given periodical event in the spring will be four days later 5° east and four days earlier 5° west and the reverse in the fall.

Mr. T. J. Headlee: What is the factor you are measuring?

Mr. A. D. Hopkins: I do not attempt to explain that. I accept the facts as I find them. Specialists in other branches of science will have to explain the controlling factors. The fact that there is a variation due to longitude has been determined in Europe as well as in this

country. There the variation was found to be nine-tenths of a day to a degree of longitude. I have found that for North America it is on the average about eight-tenths of a day to a degree or four days for 5°.

Mr. T. J. Headlee: In which direction from the base line?

Mr. A. D. Hopkins: If you begin at any point on any meridian in North America there will be a difference of about four days for each 5° of longitude, that is, any spring event, controlled by climate, will happen about four days earlier 5° west of the place and four days later 5° east of it. Isn't that clear?

Mr. T. J. Headlee: That's clear; but it seems impossible.

Mr. A. D. Hopkins: We have conclusive proofs on this map, on which it is shown that the lines of equal phenological events, according to the law, are paralleled by the sea level isotherms, the lines of northern limits of wheat, barley and potato culture, tree growth, migration of birds, etc.

(Doctor Hopkins stated that he is preparing a paper on the subject for publication.)

President C. Gordon Hewitt: I will now call upon Mr. Henry Fox to read his paper.

SUMMARY OF INVESTIGATION OF LIGYRUS RUGICEPS DeG.

By Henry Fox, *Clarksville, Tenn.*

(Withdrawn for publication elsewhere)

President C. Gordon Hewitt: The paper is now open for discussion.

Mr. E. N. Cory: I would like to ask Mr. Fox if he has made any survey on the eastern shore of Virginia.

Mr. Henry Fox: I have not been able to do so.

President C. Gordon Hewitt: I will now call upon Mr. J. W. McColloch for his paper.

WIND AS A FACTOR IN THE DISPERSION OF THE HESSIAN FLY[1]

By James W. McColloch, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

In the course of the field experiments on the Hessian fly the writer has had his attention called to many instances of serious infestations

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 22. This paper embodies some of the results obtained in the prosecution of project No. 8 of the Kansas Experiment Station.

in wheat fields where the possibility of fly infestation had seemed practically negligible. In some cases these were fields planted on corn land and far removed from other wheat fields. In numerous cases they were fields planted according to the best approved methods for controlling the fly. In still other cases infestations occurred where one farmer would lose most of his crop while his neighbor would suffer only slight injury. Investigations of many of these infestations suggested the possibility of some factor, such as migration, as entering into the problem of control.

Previous References to Migration

The fact that the Hessian fly does migrate has long been recognized, but has been given little consideration and apparently has not been taken into account in devising methods of control.

Osborn (1898, *p.* 11) says, "The powers of flight possessed by the Hessian fly are sufficient to provide for its ready dispersal over limited areas, and where there are continuous or slightly separated plantings of wheat, rye, or barley, no other means of dispersal need be sought." Further on he says that there is little tendency for the adults to leave the field.

Marlett (1900, *p.* 2) writes, "The migrating and scattering brood of adults is the one developed in the fall; the spring brood does not wander much from the field in which it is developed."

Roberts, Slingerland and Stone (1901, *p.* 256) state that the migrating brood is developed in the fall and that the spring brood is less apt to scatter. They go on to say that the flies can doubtless readily fly to nearby fields and, by the aid of strong winds, they may be carried comparatively long distances.

Garman (1903, *p.* 220) says that there appears to be something like a spring migration of adults from the early sown wheat to the younger more succulent wheat of late plantings.

Headlee and Parker (1913, *p.* 135) cite a case of apparent wind diffusion covering about one-half mile and go on to state that "while the studies . . . have shown clearly that the fly sometimes does migrate this way as far as half a mile, investigations at this station and elsewhere show that spring migration in sufficient numbers to do serious damage is rare and that wheat sown on clean land late enough to escape the fall brood is practically never seriously injured."

Headlee (1915, *p.* 5) writes, "It is frequently said by a grower that there is no use to undertake fly control because some of his neighbors will fail to do their part and the fly which they fail to destroy will render his efforts useless. In some instances studies have shown that this is partly true, but the great mass of experience does not only fail

to support this idea, but clearly indicates that the individual grower usually does realize a large measure of protection regardless of the action taken by his neighbors."

Field Observations on Migration

The writer's attention was first called to the fact that the wind might be an active factor in transporting the adult flies while studying the dissemination of chinch bugs from winter quarters in the spring of 1913. On April 20, while counting the number of chinch bugs

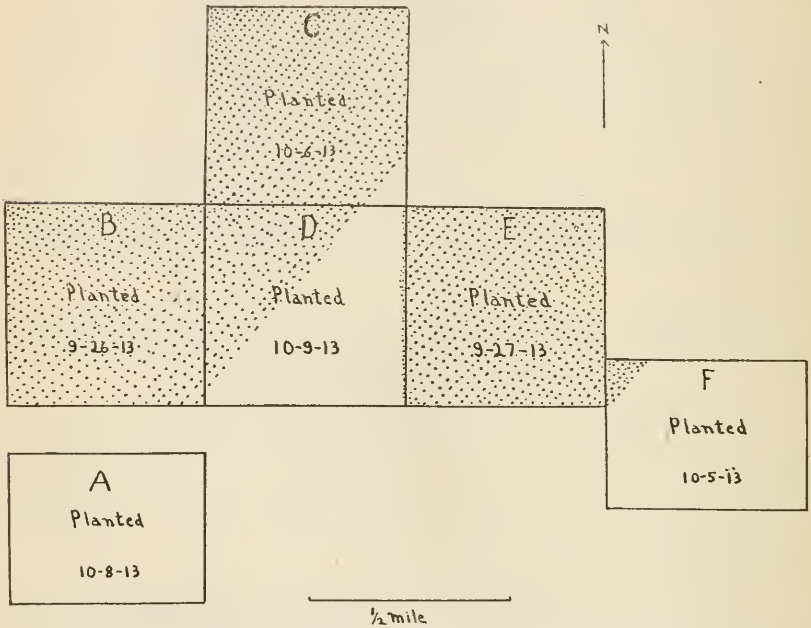

Fig. 6. Map of fields at McFarland, Kansas. Shaded area is that seriously infested at harvest.

arriving on an upright screen, a female fly was found blown against the screen. The wind was from the east at the time and the nearest infested field in that direction was over one mile away. Later on two more females were taken in the same way.

During the spring of 1914, considerable field data were collected, tending to show that the flies were being distributed by the wind. In May, 1914, the writer was requested to investigate an infestation of fly in a wheat field north of Paxico, Kansas. This field had been planted about October 10, 1913, on corn land located in the center of a large pasture. The nearest field of wheat or wheat stubble was about one

and one-fourth miles southwest. In other words, here were three conditions which would seem prohibitive to severe fly infestation, namely, late planting, new wheat land, and isolation. The writer had visited this field in December, 1913, and after a thorough investigation found no fly. On making the examination in May, 1914, it was found that 90 per cent of the plants were infested, many of them bearing as high as thirty flaxseeds and larvæ. The only apparent explanation for this heavy infestation was that the adult flies had been carried there by the wind. A badly infested field of volunteer wheat was located one and one-fourth miles directly southwest of this field, and during the period of emergence of the main spring brood of adults, the prevailing wind was from this direction.

Another example of fly diffusion due to wind is shown in Figure 6 of six fields at McFarland, Kansas. This study was made primarily to work out the value of cultural methods of control. The soil and climatic conditions are the same on all these farms and the experiment was to determine the value of the destruction of volunteer wheat and late sowing as a means of controlling the fly. On the farms A, D, and C the volunteer wheat was destroyed and the planting delayed until the fly-free date. Field F was in wheat for the first time, the preceding crop being alfalfa. On farms B and E little effort was made to destroy the volunteer wheat and planting was ten days before the fly-free date. Fields B and E were heavily damaged in the fall, while repeated search in fields A, D, C and F from November to April failed to show any appreciable fly infestation. After the emergence of the spring brood in April, however, eggs were found in large numbers over most of the shaded area. These fields were watched until harvest, at which time fields B and E were practically ruined. Field C was rather heavily infested and the northwest part of field D suffered severely. The southeast part of field D came through practically free from injury and fields A and F suffered no injury whatever. It is interesting to note that there was practically no injury along the east side of field D, although it joined one of the worst infested fields in the neighborhood. A comparison of the yields in these fields will show the true amount of Hessian fly injury.

Field A		45 bushels per acre
" B		3 to 5 bushels per acre
" C		25 bushels per acre
" D	NW	25 bushels per acre
	SE	40 bushels per acre
" E		4 bushels per acre
" F		45 to 48 bushels per acre

Evidence that the wind is an important factor in the dissemination of fly is brought out in these fields. During the time the main spring

brood was on the wing, the prevailing wind was from the southwest. Field C and the northwest part of field D were in a direct line to catch any fly that might be carried from field B. A line drawn due northeast through D from the southeast corner of field B marked the extent of serious infestation in field D. The fact that the east side of field D was uninjured, together with the non-infestation of fields A and F, is a strong point in favor of wind distribution.

Screen Experiments

In order to gather more definite data on wind dispersal of adult flies and the distance they are carried, it was planned to carry on some screen experiments about Manhattan. In order to do this it was necessary to select areas far removed from wheat fields and erect screens for catching the flies.

Two localities were chosen for this work, one for data on short distance flights, and the other for data on long distance flights. The first one was located near a small plot of wheat where migration could be studied for a range of 600 feet and the other locality was on the hills north of Manhattan where migration of from one to three miles could be studied.

At the first locality, three permanent screens were used, namely, the field insectary having a screen area of 60 square feet, located 100 feet from the infested wheat, and two smaller screens, each having an area of 6 square feet placed at 400 feet and 450 feet, respectively, from the wheat. A portable screen was used for longer distances. Table I gives the results obtained at these screens.

Table I—Showing the Number of Flies Taken in Flight at Short Distances from Wheat

Date	Hour	Wind		Distance from Wheat							
				100 Feet		400 Feet		450 Feet		600 Feet	
		Vel.	Dir.	♀	♂	♀	♂	♀	♂	♀	♂
4–11	11.30 a. m.	13 mi.	SW	52	4						
	3.00 p. m.	21 "	"			1				2	
4–12	9.30 a. m.	20 "	"					1			
	4.30 p. m.	18 "	"			2		2			
4–19	9.30 a. m.	17 "	"	1	1						
	10.30 a. m.	18 "	"	14		6		6			
	11.30 a. m.	19 "	"	17	6						
	4.00 p. m.	34 "	"			4		7			

For studying the long distance flights, a portable screen four feet square was used. This screen was moved from place to place, efforts

being made to place it in direct line with infested fields. On April 12, the first observations were made on the hills north of Manhattan. The nearest infested field to the places where the screen was operated was a volunteer field to the southwest. Table II gives the results of this day's observations.

Table 11—Showing the Number of Flies Taken in Flight at Distances Ranging from One-fourth to Two Miles from Wheat on April 12, 1916

Time	Wind		Distance from Volunteer	No. Flies	
	Dir.	Vel.		♀	♂
10.15–10.20	W SW	18 mi.	¼ mile	1	
10.25–10.35	"	18 "	½ mile	2	
10.45–10.50	"	18 "	1¼ miles	2	
11.00–11.30	"	13 "	2 miles	8	

On April 16, the screen was run from three to four p. m. at two miles from the volunteer wheat and one female was caught. In this case, the wind was slightly south of southwest and the female came from the volunteer wheat or else from the wheat plots on the College campus three miles away. The day was cool and partly cloudy and there was little activity of flies even in the wheat fields. The wind velocity was twenty-two miles per hour.

On April 18, the screen was placed on the Manhattan country club grounds from 10 to 11.30 a. m. and during that time one female was caught. The wind was very strong from the southwest, the velocity being from 24 to 27 miles per hour. The nearest wheat from this location was five miles southwest. From 12.30 p. m. to 2 p. m., the screen was run at two miles from the volunteer field mentioned above. During this time one female was caught. The wind velocity was 24 miles per hour. On April 19, the screen was again run at two miles from the volunteer wheat from 11 a. m. to 12.15 p. m. and five females were caught. The wind velocity was 19 miles per hour during this time.

General Notes

It is interesting to note that of the 146 flies taken in flight, 135 are females and that no males have been taken at a greater distance than 100 feet from wheat. As far as the writer has been able to ascertain, flies that have been carried two miles by the wind are not injured. A large number of the females taken at this distance have been placed on wheat where they began to oviposit at once. Fertilization had apparently taken place before flight, as all the eggs thus obtained were fertile.

Economic Importance and Conclusions

The fact that fertilized females may be carried long distances by the wind has an important bearing on the control of the fly. It means that coöperation must be practiced over large areas and that the individual grower cannot be promised immunity from injury even if he does prepare a good seed-bed and plants late. It means that all stubble fields and volunteer wheat fields *must* be plowed under early in the fall as they are the greatest sources of infestation.

At the place where many of these observations were made, the flies were being carried up over the hills and into the wheat fields lying on the other side in the Blue River valley. The fact that the flies were uninjured on reaching the screen would indicate that they could be carried much greater distances. The relatively large number of flies caught on the small screen area at two miles indicates the possible magnitude of these flights.

The distribution of the fly in the State of Kansas may be influenced largely by the wind. The prevailing winds of this state are from the south and southwest and it is a noticeable fact that the spread of the fly has been slowest in a southwesterly direction.

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President C. Gordon Hewitt: Is there any discussion?

Mr. E. O. G. Kelly: I am very much interested in this paper. Several years ago, about the time I first joined the Department, in 1907, Professor Webster assigned the Hessian fly problem to me for study. Shortly after that we had an extended conference regarding the Hessian fly. He informed me that he had observed them to be very numerous and in damaging numbers in one field, and across the road there would be none. He had observed that when flies were very abundant in a field, they flew very close to the ground. I have made numbers of observations on this insect in this relation, that is, its flying habits. When the adults are out in large numbers, ovipositing on

wheat in fall or spring, they fly very closely to the plants, flying short distances along the wheat row, touching the ground and plants frequently. I have seen them so thick in the fields at times that one would imagine that they were gnats and it only required that one be caught for examination to determine that they were not gnats. During the spring of 1913, I believe it was, I decided that I wanted to determine how high the adult flies would fly. I built a large frame, covering it with boards, and set it north and south, or rather, facing the south, because the wind was blowing from that direction. Tanglefoot papers, such as are used to catch flies in the dining rooms, were tacked to the board; I was amazed to find that I got flies no higher than about seven inches from the ground. I followed that observation again the next fall with the same apparatus, making similar observations. In the fall of 1914 I built a frame and covered it with wire screen. The screens were built in an infested wheat stubble field 3 feet high and 9 feet long, placed at right angles—one to catch flies which went east and west, and one to catch those that went north and south. They were painted with very thin tanglefoot in order to catch them and hold them fast. The flies being numerous at this time, less than five minutes were required to catch a number. I then noticed they were flying over the three-foot screen. I immediately proceeded to build one twelve feet high, placing it near the low one. By use of a step-ladder I found they were flying over the 12-foot board frame. The 12-foot screen caught large numbers; the amounts I will not attempt to give you. The peculiar thing which bears out Mr. McColloch's discussion regarding the wind was that the flies were always flying in the direction of the wind. One interesting observation was made in connection with the screen placed at the west edge of the field. The wind was blowing toward the west, from the direction of the infested field, many adults being caught. In thirty minutes or less, after the screen was erected, the wind changed, coming directly from the west and those flies which had been blown into a cornfield on the other side, or west, came back, or were blown back. This gave us indications, however, that the flies were flying higher than 12 feet and we accordingly erected a screen about 14 feet wide and ran it up 30 feet. We got flies at the top of the screen.

In 1915, I continued the observations on a screen 14 feet wide and 30 feet tall, erected near wheat fields. The flies were flying 30 feet regularly, but the majority were between 19 and 21 feet, and most of them on the 21st space.

Mr. T. J. Headlee: I should like to inquire whether the speaker or any one else here has any data to show the character of the wind that produced this flight.

Mr. E. O. G. Kelly: I will answer that by saying that the winds are very light when flies are flying, and during a strong wind the adults will cling close to the plants. The records I have were made at Wellington. The days on which we caught the flies, the wind velocity was less than twenty miles per hour. If the wind is higher than that, not many flies are caught.

Mr. J. W. McColloch: The records of the station bear out what Mr. Kelly just said—twenty miles is the maximum velocity.

President C. Gordon Hewitt: If there is no further discussion, we will close the reading of papers for the session.

(After conducting routine business the session adjourned.)

Afternoon Session, Saturday, December 30, 1916, 2.10 p. m.

President C. Gordon Hewitt: The first paper on the program will be presented by Mr. C. W. Collins:

METHODS USED IN DETERMINING WIND DISPERSION OF THE GIPSY MOTH AND SOME OTHER INSECTS[1]

By C. W. Collins, *Bureau of Entomology, U. S. Department of Agriculture*

In 1910, some experiments were begun at the Gipsy Moth Laboratory to determine if, and to what extent, gipsy moth caterpillars were carried by the wind. These had their inception in a small way by allowing the newly hatched larvæ to spin or drop into a current of air circulated by an electric fan. In this experiment the larvæ were buoyed up and could be seen floating from one room through another. These experiments were enlarged upon later in the season by using small poultry wire screens treated with tanglefoot. They were set up on a salt marsh area. Newly hatched larvæ were liberated from boxes fastened to a stake at given distances from the screen in the opposite direction the wind was blowing. Larvæ were caught on these screens at distances varying from 50 to 1,833 feet from liberation point and these were followed by larger experiments, the details of which, with other notes on dispersion of the gipsy moth, have been published by Burgess,[2] and later results by the writer.[3] Stabler[4] and his associate

[1] Published by permission of the Chief of the U. S. Bureau of Entomology. Other illustrations of methods used in dispersion experiments will be found in Bul. 273, Bur. Ent., U. S. D. A., 1915.

[2] Burgess, A. F. The Dispersion of the Gipsy Moth. Bul. 119, Bur. Ent., U. S. D. A., 1913.

[3] Collins, C. W. Dispersion of Gipsy Moth Larvæ by the Wind. Bul. 273, Bur. Ent., U. S. D. A., 1915.

[4] Stabler, H. P. Red Spiders Spread by the Wind. Mo. Bul. Cal. Hort. Com., II: 12 p. 777, 1913.

later discovered that the almond mite (*Bryobia pratensis*) was carried extensively by the wind, having taken it on sticky fly paper 650 feet from an infested orchard and on top of a schoolhouse 50 feet high. Quayle[1] has given us evidence that the young black scale (*Saisettia oleae*) is dispersed by the wind as it was taken in tanglefoot 450 feet from the nearest infested trees. This species was distributed over an entire four-acre block of trees, chiefly by the wind in a single season. The young of the red scale (*Chrysomphalus aurantii*) was also taken at distances ranging from 30 to 150 feet. Titus[2] has observed that young thrips are carried by the wind at a height of 20 feet.

Observations on time of hatching of gipsy moth eggs in comparison with development of foliage in 1916 showed that *Forsythia vulgaris*, a common shrub on lawns in eastern Massachusetts is approximately in full blossom just previous to hatching of the eggs. The garden cherry (*Prunus avium* L.) and pear (*Pyrus communis* L.) also blossom just previous to first hatching. Shad bush (*Amelanchier canadensis*) blossoms about this time. The late varieties of apple first begin putting out their leaves simultaneously with the first hatching. The buds of some of the hardwoods in the woodlands, such as the hickories and oaks begin putting out their leaves somewhat later than those of the apple and simultaneously with general hatching of the gipsy moth. Windspread of the newly hatched larvæ closely follows hatching and extends approximately over the same period, namely, from ten days to three weeks depending upon the season. During a long cold spring, development of the foliage and larvæ is much retarded; hence wind dispersion spreads over a longer period.

In order to determine the direction from which larvæ came when found upon a screen at a stated time, it was necessary to keep detailed records of the winds and temperatures during the dispersion period. The activity of the young larvæ is directly influenced by the temperature and hourly readings were taken daily during the period of windspread. A small weather vane was attached to one of the posts of the screen under observation and hourly or half-hourly readings recorded. By noting the time that each larva was found on the screen and figuring back to the previous examination, it was possible to give the approximate direction and source from which they came. A small hand anemometer was also used to record the velocity of the wind, an observation with which was taken hourly or every two hours. Use was also made of the same weather data collected by the U. S. Weather Bureau at Boston, Mass., Providence, R. I., Concord, N. H., and Portland, Me.

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[1] Quayle, H. J. Dispersion of Scale Insects by the Wind. Journ. Econ. Ent., vol. IX, No. 5, p. 486, 1916.

[2] Titus, E. G. Journ. Econ. Ent., vol. IX, No. 5, p. 492, 1916.

Locations for screen experiments were selected with reference to distance from infested woodlands and nature of surrounding vegetation; that is, finding areas where there was little favorable food for the gipsy moth, so that little scouting had to be done to determine if the eggs of the insect were already present. Marsh areas, beaches, and islands off the coast best met these requirements. A screen was thus located at Salisbury Beach and Plum Island, Mass., where large expanses of salt marsh from one to two miles wide separated the infested woodlands from the sandy beaches and ocean.

An altitude experiment with aviation of small caterpillars was conducted at Merrimac, Mass., which consisted of a screen 36 feet long and 4 feet high erected on top of the town standpipe. The latter was located on a hill and towered 55 feet above the summit, so that the screen was 300 feet above sea level. Other hills one-half mile and more distant, also the valleys were generally infested and 141 newly-hatched larvæ were taken in a season on this screen of 144 square feet. This experiment together with three large screens located on hilltops in New Hampshire gave data which assisted in explaining the source of many new infestations found during the scouting operations on hilltops in outside territory.

A location for a screen on the Isles of Shoals, N. H., was selected on Lunging Island, the most western of the group. These islands are located six miles from the nearest mainland and 13½ miles from mouth of the Merrimack River to the southwest. Living gipsy moth larvæ were removed from the screen during a continuous period when southwest winds were blowing, thus proving that they are wind borne 13½ miles or farther. After securing a total of 67 newly hatched gipsy moth larvæ on the screen at Isles of Shoals in 1914, nine of which were wind borne from a distance of 13½ miles or more, it was evident that the maximum distance had not been found. A location was then searched for where a screen could be erected an even greater distance from infestations, and this was found on the end of Cape Cod, Provincetown, Mass. Here a large poultry wire screen was erected on the sand about 75 feet from the shore and near Race Point Light.

Tanglefoot was applied and examinations were begun at the dispersion period of 1915. Winds striking the screen at this point from the south, southwest, west or northwest must pass over 19 to 35 miles of salt water from the mainland. Two to three examinations of the screen daily were made during the dispersion period in 1915.

In order to further check these data on long distance spread, the Provincetown screen which was razed during a storm in winter of 1915–16 was rebuilt in the spring of 1916. New wire of ¾-inch mesh was applied, as the old tanglefoot so darkens after one year that it is

difficult to find small objects upon it. It was made the same dimensions as the old one; namely, 75 feet long with wire 6 feet wide, totaling 450 square feet. Another type of screen was also used at Provincetown, which consisted of white cotton cloth three feet wide tacked to sides and ends of a small building located near the shore. The top selvage of the cloth was eight feet from the ground and contained 162 square feet to which tanglefoot was applied. While there were no caterpillars taken on the cloth screen in 1916 at Provincetown, similar cloth screens at Salisbury Beach, Mass., and Isles of Shoals, N. H., in 1913 and 1914 gave similar results to the wire screens.

Two men were stationed at Provincetown in 1916 and were able to make from 5 to $8\frac{1}{2}$ examinations daily, thus keeping the screen clear at all times in case of sudden shifts of the wind. The details of the daily catches are given in the following table for 1915 and 1916:

TABLE SHOWING NUMBER OF *P. dispar* LARVÆ CAUGHT ON SCREEN, PROVINCETOWN, MASS., 1915 AND 1916, WITH DIRECTION AND DISTANCE FROM WHICH THEY CAME

Date of Catches	Scituate and Cohasset to Duxbury, Mass. W to NW, 21-30 miles	Plymouth to Orleans, Mass. SW to SSE, 19-22 miles	Wellfleet to Truro, Mass. SE, 9-12 miles	Provincetown, Mass. E and NE, $1\frac{3}{4}$-2 miles
1915				
May 16	——	——	——	51 newly-hatched
17	——	——	——	7 " "
18	——	——	——	16 " "
19	7 newly-hatched	——	——	——
20	——	9 newly-hatched	——	——
21	——	——	——	24 newly-hatched
22	——	5 newly-hatched	——	——
24	——	2 " "	5 newly-hatched	——
25	——	——	——	2 newly-hatched
Total 1915	7 newly-hatched	16 newly-hatched larvæ	5 newly-hatched	100 newly-hatched
1916				
May 19	——	1 newly-hatched	——	——
22	——	2 " "	——	——
25	——	2 " "	——	——
26	12 newly-hatched	——	——	——
29	——	——	3 newly-hatched	4 newly-hatched
June 1	1 newly-hatched	——	——	1 " "
2	1 " "	——	——	——
Total 1916	14 newly-hatched larvæ	5 newly-hatched	3 newly-hatched	5 newly-hatched

Grand Total for 1915—128 larvæ
Grand Total for 1916— 27 larvæ

From the foregoing table it will be noted that 23 larvæ out of a total of 128 were borne by winds from the westward and south in 1915 and 19 out of a total of 27 in 1916 from the same directions. The

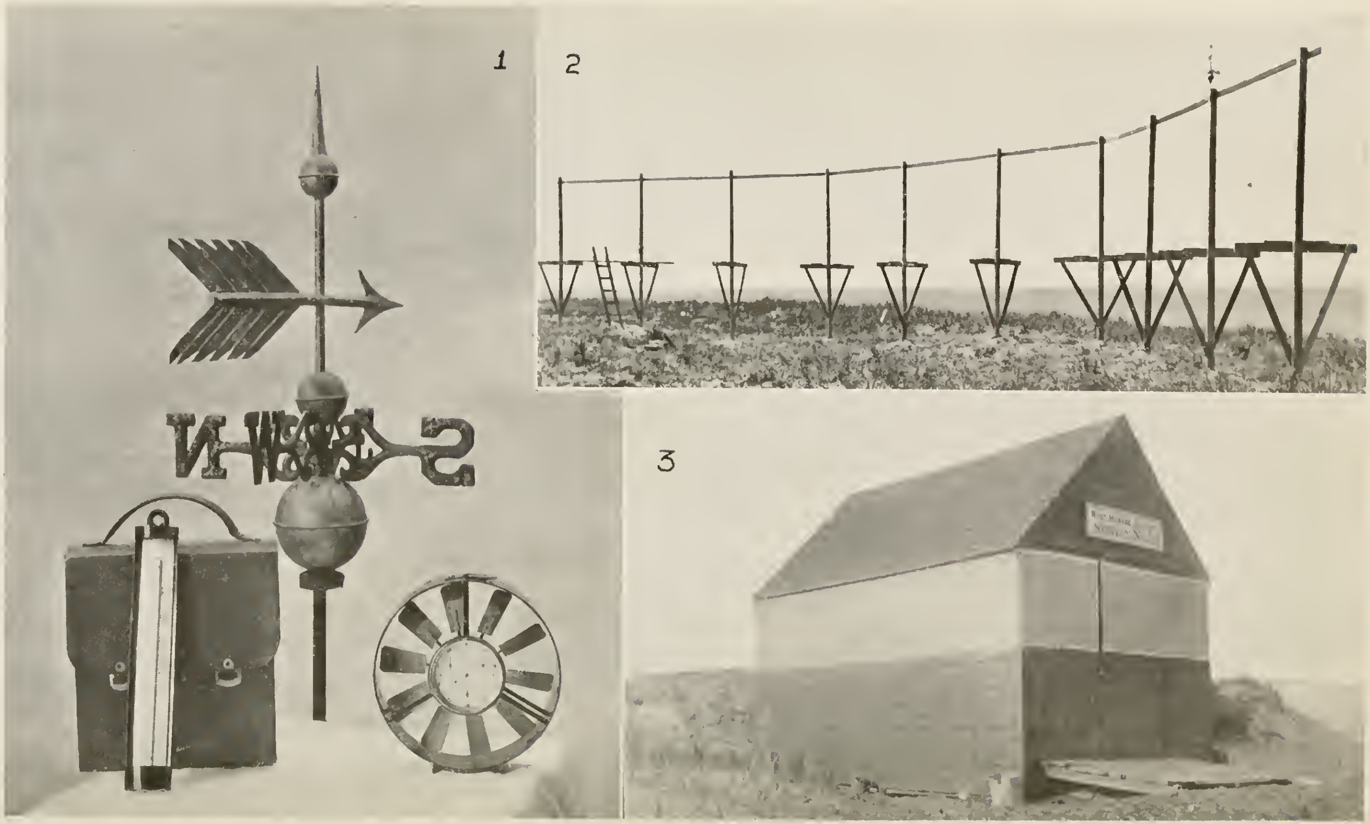
shortest distance from lower Cape Cod or the mainland in these directions is about 19 to 22 miles. Some of these larvæ which were borne onto the screen by northwest winds came from a source even more distant, namely, 21 to 30 miles. A total of 8 larvæ came from the southeast during the two years—a distance of 9 to 12 miles or more —and 105 from infestations to the eastward of the screen in Provincetown. The data collected at this screen give new records on wind dispersion of 20 to 25 miles or more and have great bearing on the proper control measures to practice in preventing spread of the insect.

The methods used to prevent spread of the gipsy moth by the Bureau of Entomology in former years were to do as much work as possible in the heavily infested area, consisting of roadside thinning, spraying and treating of egg clusters, so as to keep down such infestations and prevent larvæ being carried on vehicles and automobiles. After 1912, when the theory of windspread of the newly-hatched larvæ was proved and accepted, the base of control measures was moved adjacent to the border, especially the western, where there was greatest danger of spread eventually to central and southern United States. A strip of territory about 25 miles wide is carefully worked each year. All old infestations are cared for in this area, and when new infestations are found, creosote is applied to all egg-clusters and in many cases is followed by spraying. Tanglefoot bands are applied to trees, where the infestation is at all heavy, to prevent the small larvæ hatching on or near the ground, ascending the trees and being blown long distances by the wind.

Better results can be seen in preventing spread of the insect since the latter course was taken, as the increased territory each year since 1912 has not been so great in proportion to that previously infested.

Mr. C. W. Minott, of the Bureau of Entomology, conducted some interesting investigations during May and June, 1916, with reference to windspread of gipsy moth larvæ on cranberry bogs. The woodlands of the Cape Cod section of Massachusetts where cranberries are extensively grown, have become badly infested in some towns, and the larvæ have spread onto the bogs, thus causing trouble and alarm to the growers. In many instances, vines on the bogs have been heavily fed upon and even stripped of their foliage. The growers have met these conditions by spraying and clearing around the borders to prevent, as much as possible, the large larvæ crawling in.

Two bogs were selected for experiments on wind dispersion in Carver, Mass., namely, Muddy Pond Bog, containing about one hundred acres and Johns' Pond bog containing about forty-four acres (including pond). Six screens made of cotton cloth tacked to a frame in two sections, each being 3 by 10 feet, were set up horizontally near the vines


1
2
3
N
W
S

at various distances from the woodlands. Each screen contained 60 square feet of cloth upon which tanglefoot was applied. Daily examinations were made of each screen and data also taken on the temperature, direction and velocity of the wind during the dispersion period.

The screens were located on the bogs at various distances ranging from 400 to 1,200 feet from woodland infestations. From one screen located 600 feet from infested woodland on the northwest and 900 feet on the west, there were removed 62 small larvæ during the season, or slightly more than one to the square foot. A total of 143 small larvæ was wind borne onto the six screens, which indicated that an average of about 17,000 were blowing on to the bogs per acre. The infestations around these bogs, to date, are only medium in extent, which indicates what happens on bogs bordered by heavily infested woodlands and what the conditions will be here as the surrounding infestations increase. Concerted action is needed to prevent further increase of the gipsy moth in towns where cranberries are the main crop.

In connection with the wind dispersion experiments of the gipsy moth, data were secured on some other lepidopterous species. June 1, 1914, Mr. C. E. Hood removed from the screen at Plum Island, Mass., a living first stage larva of *Hemerocampa leucostigma* S & A. Between the period the larva was found and the previous examination of the screen, the wind blew from the southwest at a velocity of from four to five miles per hour. The nearest tree growth was some willows, two-thirds of a mile distant, across the salt marsh, and it is evident that the larva came from this source.

Some other lepidopterous larvæ were taken on screens located on the hills of New Hampshire in 1913 and 1914. These screens were located 200 to 500 feet from tree growth. One specimen taken in Hillsborough, N. H., where the nearest trees were fully 500 feet distant, was either *Hemerocampa leucostigma* S & A or *Notolophus antiqua* L. The specimen taken on the screen was so badly injured after having been removed from tanglefoot that a more accurate determination could not be made. Both the above species of larvæ are thickly clothed with very long acuminate hairs, but are not provided with hairs bearing swellings or vesicles. It was thought by Wachtl and Kornauth[1] that the latter hairs with balloon-shaped swellings made the caterpillars buoyant in the air, but more recent investigations tend to militate against that theory.

Nine specimens of a species of *Noctuidæ* were also taken on the screens. These larvæ are yellowish-white with brown chitinous plates

[1] 1893 Wachtl und Kornauth. Beiträge der Kenntniss der Morphologie, Biologie und Pathologie der Nonne (*Psilura monacha*). In Mittheilungen aus dem forstlichen Versuchsvesen Osterreichs, V. 16, 38 p., 3 pls., 8 figs.

on dorsum and laterad. The plates each bear spinules. Head and legs brown. The other species under consideration is a *Geometrid*, two small specimens being taken. They are grayish brown in color and practically nude of hairs. Specimens of the latter two species were submitted to Mr. August Busck of the U. S. National Museum for determination. All these larvæ were taken in tanglefoot in situations distant from the posts, where they could not possibly have crawled. The screens on which the latter, or practically hairless, larvæ were taken were located quite near tree growth—200 to 500 feet. The recording of three and possibly four species of lepidopterous larvæ other than the gipsy moth (*Porthetria dispar* L.) and the nun moth (*Psilura monacha*) being carried by the wind adds to the probability that there are many other species dispersed in this way.

Summary

Additional data have been collected on long distance wind dispersion of gipsy moth larvæ; namely, across Cape Cod Bay off the coast of Massachusetts. The direction of the wind recorded at the time taken and previously, indicated the source of infestation to be 19 to 30 miles distant on the mainland. Frequent examinations of the screens and close data kept on movements and direction of the winds were necessary to make these records of value.

Screens used in the cranberry bog experiments and placed horizontally over the vines were well adapted to catch the drop of small larvæ floating over such areas while the upright wire and cloth screens proved better for securing long distance spread.

The recording of three extra lepidopterous species and possibly a fourth being carried by the wind in the larval stage suggests some possibilities for investigation with others along this line.

President C. Gordon Hewitt: The paper is now open for discussion.

Mr. A. F. Burgess: Some may wonder why the *Geometrid* and

Plate 10

Fig. 1. Thermometer, weather vane and anemometer used in recording weather data in connection with Dispersion Experiments. Fig. 2. Wire screen at Provincetown, Mass., upon which small gipsy moth larvæ were taken, having been windborne about twenty-five miles. Fig. 3. Upright cloth screen; a type used in Dispersion Experiments, Provincetown, Mass.

Plate 11

Cranberry bog showing horizontal cloth screen to catch drop of wind-borne gipsy moth larvæ. Tanglefoot had not been applied to screen.

Noctuid larvæ were not more definitely determined. These caterpillars are very small, being in the first stage and after having had a tanglefoot bath, it was impossible to determine them more definitely.

Mr. J. W. McColloch: What size of mesh was used in the screens.

Mr. C. W. Collins: We used ¾-inch mesh, also ⅝-inch, but did not use the two sizes under exactly the same conditions.

Mr. J. W. McColloch: Is this cloth wire or poultry wire?

Mr. C. W. Collins: Poultry wire.

Mr. E. D. Ball: This paper opens up a very definite field for work. An observation I made this winter leads me to believe that I found San José scale infestation which had been wind borne three or four blocks, and that a single infested tree had apparently been the source of the infestation. I wonder if any of this work has been done on scale insects.

Mr. C. W. Collins: We have not done any. Professor Quayle has carried on some interesting experiments on black scale in California. He succeeded in taking them 450 feet from infested orchards and he has taken red scale 150 feet from an infestation.

President C. Gordon Hewitt: I will now call on Mr. Crossman to present his paper.

SOME METHODS OF COLONIZING IMPORTED PARASITES AND DETERMINING THEIR INCREASE AND SPREAD

By S. S. Crossman, *Entomological Assistant, Bureau of Entomology, U. S. D. A.*

The control of phytophagous insects by means of entomophagous ones may be divided into two classes: first, the control of native insects by native parasites; second, the control by importations of parasites and predaceous enemies of injurious insects which have become established in a new land. In the United States at least one half of the injurious insects of economic importance are of exotic origin and have become established in this country, because they are unhampered by many of the factors that hold them in check in their native lands. Dr. C. V. Riley, while entomologist to the United States Department of Agriculture, was the first to introduce successfully into this country a parasite of an insect of exotic origin. In 1883[1] he succeeded in establishing *Apanteles glomeratus* L. which is a parasite of *Pontia rapæ* L. Six years later *Novius cardinalis* was introduced into California.

Since Riley's successful introduction of *A. glomeratus*, many importations of beneficial insects have been made and the future undoubtedly

[1] Popular Science Monthly, vol. LXXII, pp. 363, April, 1908.

holds great opportunities for such work. With this in view it was suggested by Mr. A. F. Burgess that a paper dealing with some of the methods that are being used for colonizing imported parasites and checking their status in their new environment would prove of interest and value to others who are working with similar projects.

The methods used in introducing and establishing a new insect depend entirely upon its habits, life cycle, and seasonal history. In the time allotted for this paper, it would be difficult to deal in detail with the many parasites which are receiving attention at the Gipsy Moth Laboratory. Accordingly, I shall discuss the methods used in handling only two species, namely, *Anastatus bifasciatus* Fonsc. and *Schedius kuvanæ* How. These insects belong to the family *Encyrtidæ* and parasitize the eggs of the gipsy moth; otherwise they have little in common.

The story of the importations and successful establishment in America of these parasites is a fascinating one and has been reported by Howard and Fiske in Bulletin 91 of the Bureau of Entomology. Both were successfully colonized during the summer of 1909, *Anastatus* being liberated as larvæ within imported gipsy moth eggs, while *Schedius* were released as adults, which were obtained by breeding at the laboratory.

It is essential that the life and seasonal histories of the host and parasite be known before work of this nature can be done intelligently. The seasonal histories of the parasites with which we are dealing are briefly as follows: *Schedius* hibernates as an adult. In the spring, a week or two before the gipsy moth eggs hatch, these hibernated individuals may be found ovipositing in gipsy moth eggs, starting a spring generation, the progeny of which carries the species through the summer. In July soon after the gipsy moth eggs are laid, *Schedius* attacks them and a generation is produced about every twenty-five days, until cold weather sends them to their hibernating quarters. Four generations and a partial fifth are completed each fall by *Schedius*. *Anastatus*, on the other hand, like its host, has but a single generation. Very soon after the gipsy moth lays her eggs, *Anastatus* oviposits in them and the larva of the parasite devours the egg contents before the embryo has time to develop. It remains within the host egg through the winter and early summer, until a week or so before the gipsy moth eggs are laid, and after pupating the adult parasite issues and attacks the new eggs. It is important to note that these parasites do not disperse at an equal rate, *Anastatus* spreading much slower than *Schedius*. Also that *Anastatus* has but one generation each year, while *Schedius* has several generations. These facts have an important bearing on the plans of work.

Material for colonizing *Schedius* is obtained by breeding at the laboratory. The trays used for this work are 5 feet long, $2\frac{1}{2}$ feet wide, and 3 inches deep. They are lined with black paper and covered with white cotton cloth. Two holes twelve inches square are cut in the top, each half way between the center and end of the tray, through which the *Schedius* are fed. Sheets of glass are placed over each hole to prevent the adults from escaping. During the middle of August, about 25,000 gipsy moth egg clusters are collected from any convenient locality to be used in the breeding trays. These are then slightly broken and spread evenly over the bottom of each tray. About the same time a few hundred egg clusters are collected from some locality where *Schedius* is present and placed in glass vials, 8 inches by 2 inches, which are examined daily. Soon adult *Schedius* of the first fall brood issue and are transferred from the vials to the breeding trays, where they have an abundance of gipsy moth eggs for oviposition. In this manner each breeding tray is stocked with from 3,000 to 5,000 *Schedius*. Strips of banana peel sprinkled with sugar are placed in the trays for food for the *Schedius*. It is quite important that the breeding trays be kept in a warm room, else the parasites do not oviposit freely. The breeding trays are started at intervals over a period of two to three weeks, so that the parasites issue continuously from the eggs in the trays during the colonizing period, which extends from the last of September to the middle of November. In about twenty-five days a new generation of *Schedius* will be found issuing from the eggs in the breeding trays. Just previous to the issuing period, the trays are darkened by placing black paper over the glass in the tops and a series of one-inch holes are bored through the side, into which are inserted paper cones which hold glass tubes. Electric lights are now placed in front of the tubes and after a number of *Schedius* have entered a tube, it is replaced by an empty one. An estimate is made of the number of *Schedius* in this tube; then by gently tapping it, the *Schedius* drop into an eight-inch mailing tube. About 1,600 parasites are placed in each mailing tube, and honey and water smeared on a piece of paper is enclosed for food. These parasites are now ready for colonization and the tubes are either mailed to men in the field or taken by them for immediate liberation.

Material for colonization of *Anastatus* is obtained from collections made in the field. Large collections of gipsy moth egg clusters are made from heavily infested territory, where the percentage of parasitism is high. The following method is used: There is a strong colony of *Anastatus* in a town not far from the Melrose Highlands laboratory. The exact location where the colony was liberated is taken as the center and lines are run in eight directions: N, NE, E, SE, etc. Ten egg clusters are collected at the center and at points every hundred

yards along these lines. These collections are brought to the laboratory where the hair is removed from the clusters by rubbing them over a piece of cheesecloth drawn taut over a small tray. The eggs are examined with a binocular microscope and the percentage of parasitism determined. It is quite easy to observe the *Anastatus* maggot within the gipsy moth egg and, with a little practice, this work can be done quite rapidly. It has been found that one cubic centimeter contains on an average 1,000 eggs, so that the eggs are measured, the parasitized ones counted, and the percentage of parasitism is thus determined. The collections are continued along the lines until the parasitism drops below 10 per cent. From the territory inside the 10 per cent limit on all the lines, egg clusters are collected during the winter to obtain material for further colonization. Last year five bushels of egg clusters were collected from this colony and were sifted by means of a special machine which was devised by Mr. C. W. Stockwell of the laboratory force. This sifter not only saves a great amount of labor, but eliminates, to a great extent, the irritation in the nose and throat caused by the dust and hairs which always results when this work is done by hand. This machine is made on the principle of the old-fashioned grist-mill, but is so adjusted that the eggs are not injured. It consists of two horizontal disks three feet in diameter, which are padded on the inner surfaces. The eggs are fed to the machine automatically from a box which rests on the top. The upper disk revolves slowly, removing the hairs from the eggs as they are worked toward the circumference where they fall on to a chute and assemble in a trough. The power is furnished by a small electric motor. The hair and dust are removed through a suction pipe by means of a small electric blower.

After the eggs are sifted they are spread evenly over the bottom of the trays. Several layers of cloth mosquito netting are placed over them and the trays are made dark and tight by covering with black paper. Holes are made in the side, into which glass tubes are fitted. As the non-parasitized gipsy moth eggs hatch, the larvæ crawl up through the netting and into the glass tubes from which they are destroyed by being placed in a jar of kerosene oil. Much of the silk spun by the caterpillars becomes entangled in the netting, so that the parasitized eggs are quite free from it. After hatching is completed, the parasitized eggs, dead eggs, and egg shells are taken from the trays and separated by means of another machine devised by Mr. Stockwell. The eggs run by gravity over a chute, and at a certain point, the egg shells and dead eggs, which are lighter than the parasitized ones, are drawn off by suction, while the heavier parasitized eggs continue on into a tube at the base of the machine. As one cubic centimeter contains on an average 1,000 eggs, these are measured and placed in

envelopes, one cubic centimeter to an envelope, sealed and put in a cool place until colonizing begins.

During the fall, *Schedius* are liberated as adults in colonies of about 3,500. If the infestation warrants, the colonies are placed along all the roads in a town, 200 to 300 feet from the roadside and about two miles apart. The *Schedius* are merely shaken from the tube, a tree nearby is marked with a letter "S" and banded with white paint, and a tree on the roadside painted with a letter "S" and an arrow pointing toward the colony. A map is then drawn showing the exact location of the colony and this map is filed with the colony note.

During the spring, *Anastatus* are liberated as larvæ within the host eggs, in colonies of approximately 1,000. As this species spreads at a much slower rate than *Schedius*, the colonies are placed in infested woodlands every quarter of a mile on each side of the road, about one hundred feet from the roadside. A small tin can which has three exit holes in the side is stocked with a colony and nailed to a tree. Each can has a cover which prevents the rain from getting in and also protects the eggs from birds. The exact location of the colony is marked on a blue print map of the town and two colonies in each town are marked in the field as are the *Schedius* colonies, except that an "A" is used instead of an "S."

In the fall of 1916, over 2,500,000 *Schedius*, all of which were bred at the laboratory were liberated in fifty-nine towns in New England. The previous spring over one hundred New England towns were colonized with *Anastatus*, using over 12,000,000 parasites. To obtain the latter material, five bushels of gipsy moth eggs were collected from over 1,200 acres of woodland. In order to colonize such an enormous amount of material during a period of six to eight weeks, it was necessary to use every available man. Several states coöperated with us in this colonization and without their aid and the use of motor vehicles, it would have been impossible to complete the work.

In order to determine the success of colonizations, collections of 100 gipsy moth egg clusters are made around the center of many representative colonies. After arrival at the laboratory, they are placed in eight-inch glass tubes, numbered, and a record is made of the number of parasites that issue. The collections show that a good per cent of the colonies are successful.

To determine the dispersion and increase of *Schedius*, four lines are run to the cardinal points of the compass, using as the center, the exact location where a colony has been liberated. Collections of ten egg clusters each are made at the center and at points, every 220 yards along these lines. For *Anastatus*, eight lines are run and the egg collections are made from the center and every 100 feet for 600 feet, then every

100 yards. These lines are run to the colony limits, which in some cases is nearly two miles. At the laboratory these eggs are sifted and

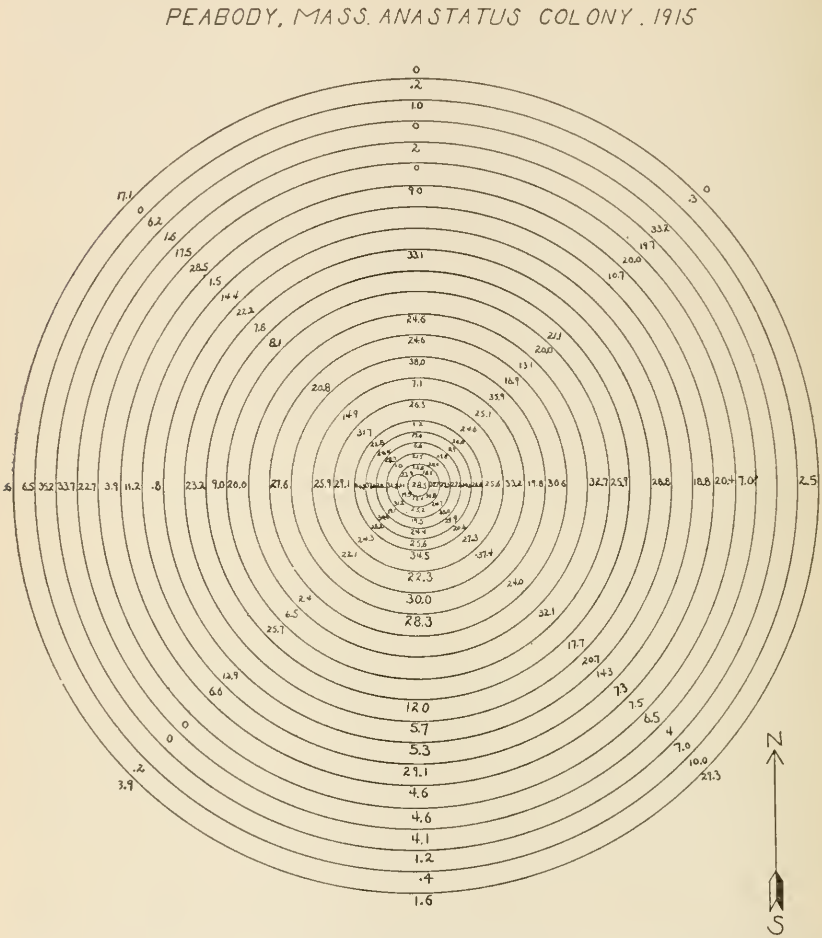


Fig. 7. The figures give the percentage of parasitism of the gipsy moth eggs at these points by *Anastatus bifasciatus*. In a few places it was impossible to make collections, such places are indicated by the absence of figures. The concentric circles represent distances of 100 yards, excepting the six inner ones which represent distances of 100 feet. The N. W. and S. E. lines run into other *Anastatus* colonies, which explains the high percentage of parasitism at the ends of these lines. This chart was prepared by Mr. R. Wooldridge and the photograph of it was made by Mr. H. A. Preston.

the amount of parasitism determined. As this work is done during the winter, the *Anastatus* larvæ are seen within the gipsy moth eggs and the parasitism by *Schedius* is determined by making a count of the

eggs that show the exit holes of this parasite. These percentages are then charted. From a study of such charts made over a period of years, the increase in percentage of parasitism and the yearly dispersion is determined.

I have tried to show by the examples of these two imported parasites, that as their seasonal histories and habits differ, so must the methods of their colonization. It takes time to develop the correct methods to use and if the preliminary work is hurried, much valuable material and information may be lost. The introduction of parasites is simply an attempt to assist in bringing about a proper natural balance in order to hold our imported pests in check.

The problem is complicated by many factors requiring careful and thorough investigation, if errors are to be avoided.

President C. Gordon Hewitt: Is there any discussion?

Miss Brace: Is any provision made for air in the breeding trays?

Mr. S. S. Crossman: The trays are not air tight but no special arrangement to admit air is necessary.

President C. Gordon Hewitt: Mr. J. W. McColloch will present the next paper.

A METHOD FOR THE STUDY OF UNDERGROUND INSECTS[1]

By James W. McColloch, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

With the establishment, in 1914, by the Department of Entomology of project No. 100, which deals with a study of those insects injuring the roots and germinating seeds of staple crops, such as white grubs, wireworms, and false wireworms, it was found necessary to devise some methods for rearing the various species concerned. Davis[2] describes a number of cages which he has found successful in the rearing of white grubs and the writer, after trying several of them, found the one- and two-ounce salve boxes the most satisfactory, because the individual insects could be followed throughout their growth. During the summer of the first year, an attempt was made to rear the insects in the field insectary, and under compost heaps, as suggested by Davis, during the winter.

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 24. This paper embodies some of the results obtained in the prosecution of project No. 100 of the Kansas Agricultural Experiment Station.

[2] Davis, J. J., Cages and Methods of Studying Underground Insects. Jour. Econ. Ent., vol. VIII, 135–139, 1915.

The work had not progressed far until it was found impossible, owing to the wide range of temperature, to rear these insects under field insectary conditions. In summer, it was not unusual for the temperature to reach 100° or more and during the winter it fell to 20° below zero. Since these extremes were far in excess of those that would be encountered under natural conditions, they resulted in a high mortality. Inasmuch as it was desired to observe the insects during the winter, it was not feasible to place the insects under compost heaps during this period.

Another objection to placing the salve boxes under piles of compost is the difficulty in knowing just how much moisture is needed in the boxes. The writer has also found that unless exceptional care is taken the soil and food will mould in the course of three or four weeks and make the boxes untenantable. With these objections in mind, it was decided to try carrying the material through in a cave where the temperature could be kept above freezing and where the boxes could be examined at regular intervals.

In the fall of 1915, a temporary cave was constructed for this purpose. A hole three by five feet was dug six feet in the ground and the sides boarded up sufficiently to prevent caving in. A board roof was placed over the hole about five feet from the bottom and was covered with a foot and a half of dirt. A manhole opening was left in one corner for admittance. This opening was closed with a heavy door covered over with a few layers of burlap. The bulb of a soil thermograph was placed in the cave. The instrument itself was inclosed in a small box on the outside so that the temperature could be determined without opening the cave. A set of maximum and minimum thermometers were also kept in the cave as a check on the thermograph. With the approach of cold weather early in October, about twenty species of insects were placed in the cave and kept under observation during the winter. Every two or three weeks all the boxes were gone over, the soil changed, and fresh food supplied. Table I gives a list of the insects successfully carried through the winter.

All of the insects appeared to thrive under these conditions during the winter and the mortality was very low. The writer has been attempting to carry corn ear-worm pupæ through the winter for several years, but always with negative results because the mortality would be from 75 to 100 per cent. With the material kept in the cave, less than 25 per cent died. The behavior of many of the insects kept in the cave was checked with field observations to determine what variations, if any, occurred. Corn ear-worm larvæ, placed in the cave early in October, pupated at the same time as did those in a check kept in the field insectary. In the spring, the adults emerged during June which

is the normal time of emergence in the field. Grasshopper eggs hatched in the cave at the same time that eggs were hatching in the field. The larvæ of *Eleodes opaca* and *E. tricostata* pupated in the spring and the adults emerged at the same time that fresh adults were being found outside.

Table 1—List of Species Carried Through the Winter in the Cave

Family	Species	Stage
Myriapoda	Julus sp.	Adults
Acrididæ	Melanoplus differentialis	Eggs
Tipulidæ	(undetermined)	Larvæ
Noctuidæ	Peridroma saucia	"
"	Heliothis obsoleta	Pupæ
Carabidæ	Harpalus sp.	Larvæ
Scarabæidæ	Lachnosterna knochii	"
"	" rubiginosa	"
"	" crassissima	"
"	" lanceolata	"
"	Ligyrus gibbosus	Adults
Elateridæ	Monocrepidius vespertinus	Larvæ
"	Melanotus communis	Larvæ and adults
"	Lacon rectangularis	Adults
Meloidæ	Epicauta maculata	Larvæ
Tenebrionidæ	Eleodes opaca	Larvæ
"	" tricostata	Larvæ and adults

A study of the temperature records of the cave is very interesting. From October 11 to November 8, the average mean temperature was about 63° with a daily range of from one to two degrees. From November 8 to February 11, the temperature gradually fell from 62° to 37°, a drop of 25° in 95 days, or an average of about one-fourth of a degree per day. From February 11 to March 6, the temperature remained practically constant at from 37° to 38°. On the latter date it gradually began to rise. From January 17 to March 18, a period of 61 days, the temperature remained constant at from 37° to 40°. The daily fluctuation of temperature within the cave, with the exception of one day, did not exceed two degrees. There were 62 days when it remained constant, 101 days when there was a one degree fluctuation and 26 days when the range was two degrees. The average daily range of temperature outside for this same period was 21.5°, with extremes of 3 and 50°. On January 11 to 13, the outside temperature fell from 53° to −16°, a drop of 69°, while there was a drop of only 3° in the cave. The average mean temperature of the cave and the outside, together with the range of temperature in the cave, is shown in the accompanying chart (Fig. 8).

This temporary cave proved so successful that in the summer of 1916 a permanent cement cave was constructed. The floor of this

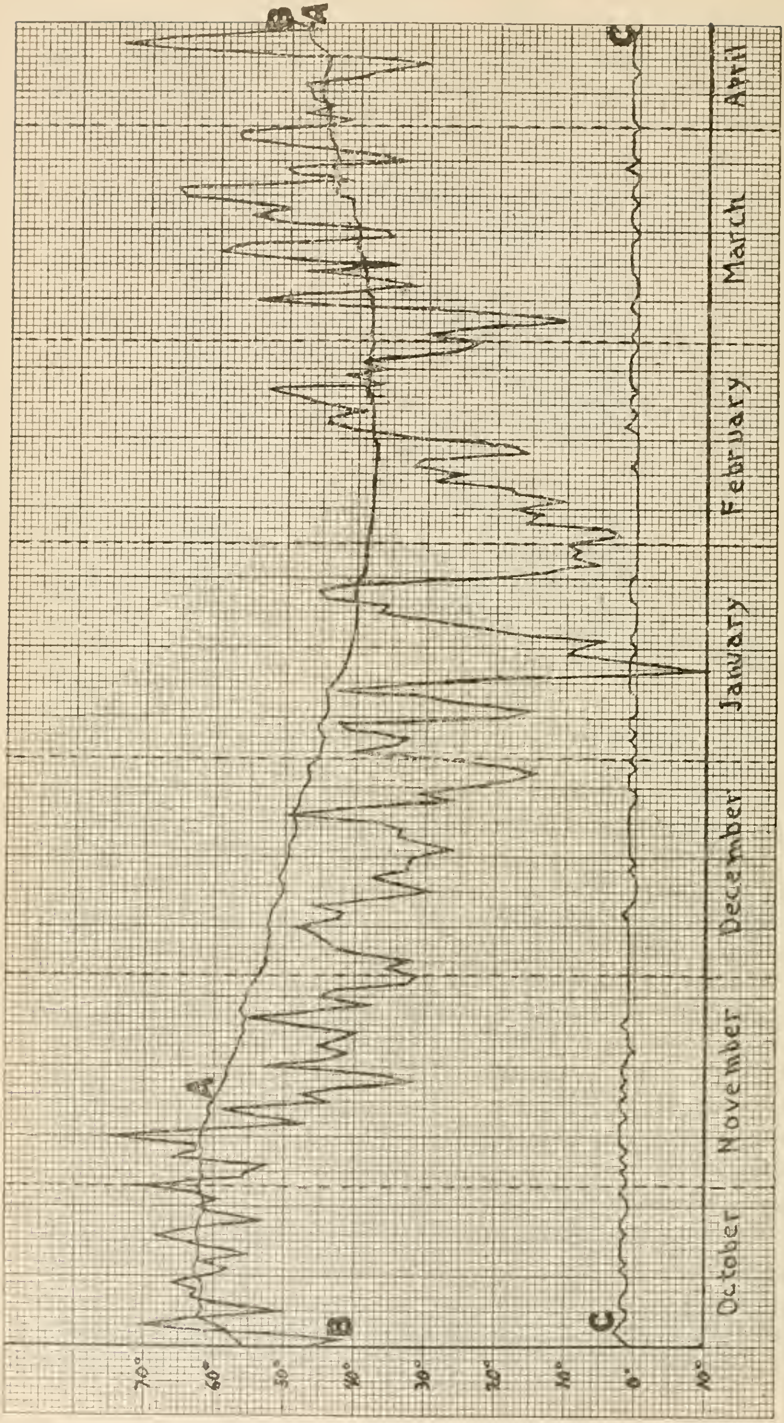


Fig. 8. Chart showing a comparison of the mean temperature of the cave and the outside, and the range of temperature in the cave from October 8, 1915, to April 15, 1916. A. Average daily mean temperature in the cave. B. Average daily mean temperature on the outside. C. Daily range of temperature in cave.

cave was placed eight feet below the surface of the ground and the roof two feet below the surface. The floor space of this cave is five by seven feet. The walls, roof and floor are six inches thick, and the roof is reinforced. The entrance is through a manhole at one corner with an iron ladder leading down to the floor. The advantage of the manhole type of entrance is that it does not cause much change of temperature when opened. The temperature was recorded in the same way as in the case of the temporary cave.

This cave was completed about the last of July and since then has been used in the rearing of white grubs, wireworms, and false wireworms, as well as a number of other species. It has proved even more satisfactory than the first cave and the temperature control has been even better. From August 1 to November 1, the temperature was held at from 75° to 65° and since then there has been a gradual decrease, amounting to about one-eighth of a degree a day. The daily fluctuation of temperature is also less in the cement cave. A number of experiments were made during the summer to determine what influence the cave had on the life-histories of various insects. Three generations of the chinch bug egg parasite (*Eumicrosoma benefica*) were reared in the cave and the life cycle coincided with that of the check reared in the field insectary. Eggs of the false wireworms and corn ear-worm hatched in the same length of time as those in the check. During the time these experiments were being run, the temperature of the field insectary was varying from about 60° to 70° at night to about 100° during the day, with a mean of about 80°. The temperature of the cave was practically constant, being about 78°.

The possibilities of this method of rearing insects, especially of subterranean forms, seems to be very promising. The temperature can be controlled to a much better extent than in many forms of elaborate apparatus. The fact that the daily range of temperature is so small makes it possible to hold it at any desired degree for weeks at a time. It is very probable that a carbon electric light connected with a switch in the thermograph house would make it possible to quickly rectify any drop in temperature. The conditions encountered in the cave did not materially influence the insects under observation and the length of the stages was the same as in the checks reared in the field insectary. In fact, the conditions in the cave appeared to approximate those that would be encountered in the field by the subterranean forms studied.

President C. Gordon Hewitt: This paper is now open for discussion.

Mr. Franklin Sherman, Jr.: The paper just presented covers a

study of certain little known insects. It is very important to determine these matters. In North Carolina we are attempting to make an insect survey and are preparing a tabulated list of the insects of the state. We have considerable information on hand and would be glad to furnish data that would be of interest to others. I mention this now so that any of the members may take advantage of the opportunity if they so desire.

President C. Gordon Hewitt: I am sure the members will welcome the spirit shown by North Carolina. I will now call for Mr. Zappe to read his paper.

EGG-LAYING HABITS OF DIPRION SIMILE HARTIG[1]

By M. P. Zappe, *New Haven, Conn.*

This European sawfly was first found in Connecticut during the annual nursery inspection in August, 1914. At that time we found many nearly full grown larvæ and a few cocoons. During the summer of 1915 some observations were made on its life-history, but the facilities for carrying on this line of work were not very good. The following spring (1916) an outdoor insectary was built in which were planted several species of pine to be used as host plants.

Oviposition

As soon as the female sawflies emerge from the cocoons in cages, they begin to run aimlessly about, going all over the pine twigs. This continues for an indefinite period of time, usually about twenty-four hours; then they begin to deposit eggs. When the female is ready to oviposit, she places herself on the pine leaf or needle facing the tip. She grasps the needle securely with her tarsi, the hind legs extending a little beyond the end of her abdomen. The ovipositor is then inserted in the edge of the needle, and she begins to saw a slit in it, working from the base toward the tip. When the incision is about one tenth of an inch long, she rests for a few seconds and then lays the egg in the slit, gradually drawing the ovipositor backward and out of the needle. This leaves a ridge of resin and sawed pulp from the leaf as a covering for the egg. The sawfly then moves forward and inserts the ovipositor immediately in front of the egg just laid and begins to saw a place for another egg. The time required to lay a single egg is about four minutes in *Pinus excelsa* and about five minutes in *Pinus densiflora.*

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[1] Jour. Econ. Ent., vol. VIII, p. 379, June, 1915; vol. IX, p. 281, April, 1916.

Hosts for Egg-Laying

In captivity the female sawflies have laid eggs in several species of pine as follows:

Pinus excelsa, Japan or Bhotan pine *Pinus cembra*, stone pine *Pinus flexilis*, limber pine *Pinus strobus*, white pine *Pinus koraiensis*, Korean pine	Five needles
Pinus sylvestris, Scotch pine *Pinus densiflora*, Japanese red pine *Pinus montana*, mugho pine *Pinus resinosa*, red pine *Pinus ponderosa*, bull pine *Pinus laricio var. Austriaca*, Austrian pine	Two needles
Pinus rigida, pitch pine	Three needles

A few eggs were also laid singly on white spruce, although attempts to obtain eggs on hemlock, larch, Japanese umbrella pine, and white fir, failed. Out of doors the sawflies showed a decided preference for the five-needled pines, although larvæ have been found feeding on other species. *Pinus excelsa* seems to be preferred above all others.

Parthenogenesis

Copulation was not observed and seems to be wholly unnecessary, as the eggs develop and hatch just the same if males are not present. Apparently it makes no difference as to the number of eggs laid whether or not males are present at the time the females are ovipositing. Some oviposit when males are present, others do not; the same is also true when males are absent.

In three cases the adults reared from eggs laid by virgin females were all males, but this may not hold true upon further investigation. In fact, some of the second brood 1916 cocoons are of large size and look as if they might yield females.

Number of Eggs Laid

The female sawflies usually begin to oviposit about one day after emerging from the cocoons and live for about seven days, while those individuals which do not oviposit die in four or five days. Length of life of males varies, some live longer than the females and some do not.

Upon dissecting the bodies of females from overwintering cocoons an average of 58 eggs per female was found, while the eggs in a female

of the first brood averaged 76. The highest number of eggs laid by a single female was 128. This is a larger number of eggs than we ever dissected from any female's body. The average number of eggs laid was 64. The number of eggs laid in a single needle varies from 1 to 20, the average number being 6. The eggs are usually laid in needles of the previous year's growth, if any are present. The majority of the eggs for the first brood in Connecticut hatch during the first half of May, while those for the second brood hatch early in August, but the broods overlap. It sometimes happens that some of the first brood of females are so late in emerging that the eggs which they lay do not produce larvæ until after some of the second brood eggs have hatched.

President C. Gordon Hewitt: Does any one wish to discuss this paper?

Mr. R. L. Webster: I am much interested to know that Mr. Zappe reared sawflies from unfertilized eggs. In work with *Harpiphorus maculatus*, I had a similar experience, although I secured one female from an unfertilized egg. I am wonde ing what the experience has been of other men who have worked with sawflies.

Mr. Max P. Zappe: By next spring I may know more about this as I now have several cocoons reared from eggs of virgin females from which adults have not yet emerged.

President C. Gordon Hewitt: In my own study with the larch sawfly, *Nematus erichsonii*, the female was quite common in that species but both sexes were reared from unfertilized eggs.

If there is no further discussion, the next paper will be given by Mr. Manter.

NOTES ON THE BEAN WEEVIL (ACANTHOSCELIDES [BRUCHUS] OBTECTUS SAY)

By J. A. Manter, *Storrs, Conn.*

The common bean weevil is considered by many entomologists as the most destructive pest attacking beans. It is especially injurious in the Southern States. This beetle was first described by Thomas Say in 1831 but did not attract notice as an economic species until 1860 when infested beans were sent to Doctor Fitch from Providence, R. I. During the next ten years it was reported from several widely separated states and now is common throughout the country.

At first the bean weevil was credited with habits similar to those of the pea weevil (*Laria pisorum* L.) and the same control measures were recommended for each. When the life-history was studied it

was found to differ in several important points and to require somewhat different methods of control. These errors were copied and recopied in many of the bulletins of our experiment stations for it was not until about twenty-five years ago that some of the most important phases of the life-history were correctly ascertained. Doctor Lintner proved in 1891 that the bean weevil bred continuously in dried beans, which was the most important observation made. There are a few minor observations still to be corrected or yet to be made.

The Egg

Doctor Chittenden gives the measurements of the egg as .55–.7 mm. long, being 2½ times as long as wide. The average of several eggs which I have measured proved to be .84 mm. long and .30 mm. wide at the greatest diameter. The smooth white eggs are cylindrical ovate and oftentimes slightly curved so as to resemble bananas in shape. In storage the eggs are laid loosely in the container, at times being fastened to the beans or receptacle and also may be deposited in the exit holes in the beans. They may be laid singly or several in a cluster. Lintner states that the "eggs are laid narrower end lower when attached at an angle." I found of 261 eggs attached at an angle that 134, or more than one half, were placed with the larger end lower. The eggs are so light that it would take nearly 40,000 to weigh a gram. The lengths of the different life stages vary with the temperature and the season. In my experiments the egg stage has varied from 7 to 17 days, the average for December at room temperature being 10 days. Just before hatching the dark colored head of the larva shows through the walls of the egg shell.

The Larva

The larva leaves through an irregular opening made in the larger end of the egg. At first it has long legs with which it crawls about seeking a suitable place at which to enter the bean. Lintner states in his seventh report "it is highly probable that the aid given the larva by the walls of the egg shell while still within it in concentrating, guiding, and sustaining its muscular efforts, or that afforded by some surface in contact as of an adjoining bean or the enclosing bag or jar, is essential to its effecting an entrance." I had noticed that the larvæ always entered the bean where it was in contact with another bean or other object. Beans were supported on the ends of pins and several larvæ placed on each. Many of them crawled down the pins while a few entered the beans alongside of the pins. None entered elsewhere. A small amount of vaseline was placed on the next lot around the points so that the larvæ could not leave by this route nor burrow into

the beans at this point. No larvæ entered the beans. Larvæ in the act of chewing their entrance holes have their bodies arched against some surface as if braced against it. I do not think the larvæ secure any aid from the walls of the egg shell but evidently they do require a position where they can brace themselves and so exert their muscular efforts to the best advantage in order to penetrate the hard coating of the bean. They take advantage of any break in the surface of the bean and also the entrance hole left by another. Several larvæ may enter through the same hole, each branching off into a new channel soon after entering and taking up a feeding area of its own. The entrance hole has a diameter of about .232 mm. and is filled with fine white powder, some of which may be scattered around on the surface. The legs are lost soon after entering. The number of days required for the larva to become full grown has varied from 27 to 54.

The Pupa

The pupal cell, lined in white, is located adjacent to the surface of the bean with some of the testa chewed away, so that only a very thin translucent membrane separates the insect from the outside world. This area becomes dark when the pupa beneath changes into the adult. The snowy white pupa gradually darkens, the eyes, mouthparts, and wings being the first to change. The time elapsing from the formation of the pupa to the emergence of the adult has varied from 8 to 20 days.

Doctor Lintner states that the lid of the exit hole is not formed by the larva but by the beetle and that it is not formed at the semi-transparent spot made by the larva "but removed a little therefrom, perhaps slightly more than the cell's length." From my observations I find that the lid is cut out of the translucent area made by the larva. The adult cuts around and through the circumference of the lid so that it can be pushed open or away. Thus the larva and the adult each have their share in forming the lid of the exit hole.

Adult

The adults may mate almost immediately after emerging and the female may even lay eggs within 24 hours. Females kept away from beans will refrain from laying eggs for several days while those with beans will lay soon after mating. The egg-laying period varied from 3 to 18 days; the average for 37 females was 8 days. The number of eggs laid by individual females varied from 5 to 75 with an average of 45 eggs. The length of life of the adult in stored beans is not long, usually about 10 or 12 days if they are allowed to mate and oviposit normally. I think that the female lives the longer. There is a wide

variation in the size of the beetles as the largest may weigh five or six times as much as the smallest.

Control

Fumigation with carbon bisulphide is the common method of control. If one has only a small quantity of beans to treat he may not wish to use this method. The bean weevil in all its stages may be killed by heat without injuring the beans. The embryos are killed in 10 minutes at 52° C.; newly hatched larvæ, in 7 minutes at 55°; full grown larvæ in beans, in 20 minutes at 55°; pupæ in beans, in 25 minutes at 55°; and adults in 4 minutes at 55°. In practice these short exposures will not be sufficient but the length of treatment must vary with the quantity of beans and the type of receptacle. It required nine hours for the center of two quarts of beans enclosed in a tight paper bag to reach the surrounding temperature of 55° C. The seed should be spread openly in shallow layers and subjected to a temperature of 55° for about an hour. According to the investigations of others the germinating power is not injured at this temperature. The bean weevil will not breed at cold temperatures. It would be a good practice to place beans in cold storage or to expose them to the cold winter weather.

President C. Gordon Hewitt: The last paper on the program will be given by Mr. I. W. Davis.

THE PRESENT STATUS OF THE GIPSY AND BROWN-TAIL MOTHS IN CONNECTICUT

By Irving W. Davis, *New Haven, Conn.*

The gipsy moth of Europe was first taken in Connecticut in Stonington, which lies in the southeastern corner of the state, in July, 1905, when Mr. Ernst Frensch, an amateur collector, caught two female moths. This was not reported, however, until March, 1906, when it became known through correspondence between Doctor Britton and Mr. Frensch. Scouts were immediately employed, who determined the extent of the infestation, which contained less than a square mile of territory, and control measures were practised. This work was continued from that time until 1914, but no trace of the pest was found from 1911–1913, and the windspread of that year, which infested several towns in the eastern end of the state, is now believed to have caused this reinfestation.

Late in the year 1909 a colony of gipsy moths was located at Wallingford, about fifteen miles north of the city of New Haven, and a force of men under Mr. D. J. Caffrey (now of the Bureau) began the work of extermination. This work was done very thoroughly and although over 8,000 egg-clusters were destroyed that first winter, at the end of four years no trace of the moth was found. The scouting, however, was carried on for two years thereafter.

Following the discovery of five gipsy moth caterpillars at the Stonington infestation in the summer of 1913, a force of Federal scouts was sent to Connecticut, and during that winter found ten towns along the eastern border of the state slightly infested with this pest. None of these localities contained any old egg-clusters, and it is, therefore, believed that the spread occurred during the spring of that year. In the winter of 1914 this area was again scouted, together with the territory just to the west of the infestations, and ten more towns were found infested, but as before the infestations were light, in many cases only a few egg-clusters being found in a town. In the fall of 1915 on account of increased appropriations, the state was able to put more men in the field than formerly, although the Federal men still scouted the outside towns. During that winter one new town was found to contain the gipsy moth, making a total of 21 towns which together have an area of about seven hundred and thirty square miles. Five towns, however, where the moth had been taken in previous years were found free of the pest, and the number of colonies was greatly reduced.

Wherever egg-clusters have been found, they have been soaked with creosote, and in the larger infestations all underbrush has been cut and burned. Tanglefoot bands are applied the following spring to all trees, including and within 100 feet of the infested trees. In 1916, 13,165 such bands were applied. Sixty of the larger infestations, especially those showing caterpillars, were sprayed in June with arsenate of lead.

The heaviest infestations at the present time are in the northeastern corner of the state with scattering colonies south to the coast but in no locality have they been found in sufficient numbers to cause any noticeable injury. The largest colonies have consisted of 400 egg-clusters, but only two such have been found. The scouting work which has been done thus far this winter gives evidence of another, but shorter, windspread than that of 1913, for in the northeastern corner of the state a large number of infestations have been found which contain but a single egg-cluster each, and there is a marked falling off in these as the work is carried westward.

The brown-tail moth was first found in Connecticut at Thompson

in the spring of 1910, and as in the case of the gipsy moth, the heaviest infestations have been confined to the northeastern corner of the state. During the winter of 1910–1911 several towns in this section were scouted and a total of 7,133 winter webs were destroyed. Since that time the winter scouting has been continued, and at present there are 72 of the 168 towns in the state that are within the quarantined area.

The last legislature passed a law which provided that the towns were to do the moth work within their limits, whenever the state entomologist should deem it necessary, and through this means four towns, namely, Putnam, Thompson, Woodstock, and Pomfret were scouted in the winter of 1915–1916 and a total of over 14,000 webs were destroyed. It has also been our practice to have the towns bordering the infested district scouted, and if these are found to be infested, to scout to the west until no evidence of the pest was found. During the last two years no new towns have been added, and a marked decrease in the number of webs in the border towns has been noticed.

Some of the towns in the older infested areas have been examined this winter to ascertain the seriousness of the infestations, but so few webs have been noticed, that it is doubtful if it will be necessary to require any of the towns to do that work this winter.

(At the close of the business session, which has already been reported, the meeting adjourned.)

A. F. Burgess, *Secretary*

Meeting of Section on Apiary Inspection

The Section met in the American Museum of Natural History, New York, December 27, 1916. The following persons were in attendance.

E. G. Carr, New Egypt, N. J.; E. F. Phillips, Washington, D. C.; Franklin Sherman, Jr., Raleigh, N. C.; George H. Rea, Raleigh, N. C.; C. S. Bukurth, New Brunswick, N. J.; George A. Dean, Manhattan, Kansas; H. B. Hungerford, Manhattan, Kansas; Frank C. Pellett, Atlantic, Iowa; E. N. Cory, College Park, Maryland; James S. Hine, Columbus, Ohio; Max Kisliuk, Jr., Columbus, Ohio; Charles A. Weigel, Columbus, Ohio; G. W. Underhill, West Raleigh, N. C.; H. Spencer, West Raleigh, N. C.; J. A. Manter, Storrs, Conn.; P. T. Barnes, Harrisburg, Pa.; H. E. Backus, North East, Pa.; J. G. Sanders, Harrisburg, Pa.; E. D. Ball, Madison, Wis.; George G. Atwood, Albany, N. Y.; A. F. Burgess, Melrose Highlands, Mass.; B. N. Gates, Amherst, Mass.; T. J. Headlee, New Brunswick, N. J.

A number of interesting papers, published elsewhere in this report, were given and generally discussed by those present.

Dr. T. J. Headlee reported that he had conferred with the membership committee as instructed at the Columbus meeting, relative to having all apiary inspectors admitted to associate membership in the American Association of Economic Entomologists, and that this committee gave no definite promise to comply with the request but would recommend any to associate membership who could qualify according to the requirements of the Association.

The committee appointed to draft a form for reporting apiary inspections submitted an outline which was acted upon, item by item, and finally adopted in the form given below:

REPORT OF APIARY INSPECTION

(State.................................Date)..........................

Number of apiaries visited..

Number of apiaries revisited during season..................................

Number of colonies of which information is gained...........................

Number of colonies carefully examined.......................................

Number of colonies found with American foulbrood............................

Number of colonies found with European foulbrood............................

Number of colonies found with sacbrood......................................

Number of permanent inspectors employed.....................................

Number of temporary inspectors employed.....................................

Number of days' service of temporary inspectors.............................

Per diem of temporary inspectors..

Cost of inspection per colony...

Reason if any for large cost per colony.....................................

....

Outline of policy pursued...

....

....

....

Official in charge...

It was moved by Dr. E. D. Ball that a committee be appointed to collect, file and disseminate the information secured from these reports. Motion carried.

E. F. Phillips, Morley Pettit and G. M. Bentley were appointed on this committee.

Dr. B. N. Gates moved that these reports be made in duplicate and mailed to the committee chairman as soon as the data are available. Carried.

Dr. E. F. Phillips moved that the Association of Economic Entomologists be requested to designate this section as the Section on Apiculture. Carried.

Dr. B. N. Gates was elected Chairman of the Section and N. E. Shaw was reëlected Secretary.

SOME NEW AND PRACTICAL METHODS FOR THE CONTROL OF EUROPEAN FOULBROOD

By E. G. Carr

Whether the treatment for the control of European foulbrood, without destroying the combs, which shall be discussed, is new or old, it has received little or no official endorsement up to the present. The advantage of a practical method whereby the diseased brood combs are easily made fit for further use is so great that it seems worth while to encourage every effort made with that end in view.

There are three principles involved in the treatment of European foulbrood without destroying the combs. These are, a strong colony, the cessation of brood rearing in the diseased combs for a time and good Italian stock.

Occasionally the disease disappears from a colony with only two of these conditions present.

Many working on the problem have suggested requeening, queenlessness and Italian stock, either singly or in combination.

Simmons[1] in 1904 gave the combination practically as now used, but it seems to have attracted but little attention until 1905 when it was published in the November 1 issue of *Gleanings in Bee Culture* and called the Alexander treatment. Mr. Alexander claims to have been using this method for three years when it was published. He does not say it was original with him nor how he came by it.

At this time the method was tried by many and while a few reported success, the majority reported failure.

This apparent failure of the plan put a check on its further trial by many. In fact, a great cry of protest went up from beekeepers and bee-inspectors and the editor of *Gleanings* regretted having published the plan.

It is a common fault with beekeepers (it may be true also of others) to adhere strongly to their own preconceived notions and, unconsciously perhaps, modify a plan so that it lacks some essential feature. This is just the way all failures of this plan with which the writer is familiar, came about.

The Strong Colony

The first step in treating a colony having European foulbrood by this modified method is to make it strong if not already so. The chances are much against a colony infected with European foulbrood being strong. However, since some colonies show a high resistance

[1] Simmons, S., 1904. Modern Bee Farm, revised edition, London.

to this disease, some may be found strong notwithstanding the fact that they are diseased.

No one who has not had the opportunity to note the different ideas among beekeepers as to what constitutes a strong colony, can form an idea of this difference. So great is it, that what one would call a strong colony another might consider only a nucleus.

Too small a colony was often the cause for failure to overcome this disease by this modified treatment.

It is highly desirable that the colony be strong in *young* bees since these are the ones which are credited with cleaning up the combs. Economy demands that the colony be properly strengthened without an unnecessary drain upon the strength of other colonies, hence it is desirable to know the minimum strength of a colony which may reasonably be expected to clean out the disease.

Doctor Miller and the Dadants have been successful in combating European foulbrood by the dequeening plan and they agree on the amount of brood and bees in the colony necessary for success. While the size of hive and frame used by each is different, they consider an amount of brood approximating that equal to five Langstroth size frames well filled, or about 500 square inches, and enough bees to cover well six Langstroth size frames, sufficient.

To secure the proper strength, adding to the weakened colony frames of emerging brood is usually recommended. When this is done, frames of comb must be taken from the infected colony to make room for the added frames of brood and these removed frames may be a source of infection when placed in another hive. For, it must be borne in mind, this plan makes no provision for the destruction of combs. An equally effective and safe way is to shake combs of bees in front of the colony to be strengthened. The old bees fly back to their hive and the young bees enter the colony needing them.

Dequeening

The object of dequeening, or caging the queen within the hive, is to stop brood-rearing; thus checking the multiplication of the bacterium responsible for disease by bringing on a dearth of suitable soil in which it may develop, and giving the bees an opportunity to catch up with their house cleaning. Simmons did not give any definite time for leaving the colony queenless, but the plan as given by Alexander calls for 27 days during which no eggs are produced in the hive. His theory was that all brood should be allowed to emerge before the deposition of eggs was allowed.

Even the most casual observer has not failed to note the striking difference in the ability or inclination of different colonies to clean out

diseased larvæ. This may be accounted for by the greater or smaller proportion of young bees in the colony or by the difference in the race or strain of bees. However this may be, the economical management of the apiary demands that a colony be without a laying queen only so long as is necessary to accomplish a desired result.

Doctor Miller, in applying this so-called Alexander treatment, made an error by giving a *laying queen* at the end of twenty-one days instead of *a ripe cell.* The period of no egg production in the hive was thus reduced from 27 to 21 days. Further experimentation has resulted in overcoming the disease by a break of ten days in egg production, this reduction in time being governed by the amount of infection and the activity of the bees in cleaning up. It is clearly seen, then, that to fix an arbitrary limit to the time of queenlessness would unnecessarily interfere with the work of some colonies.

Giving a Good Italian Queen

The word "good" as here used really means a queen whose offspring show disease-resistant qualities. It is entirely possible that such qualities might be found in any race of bees, but since the Italians have proven to be resistant, a good Italian queen is usually specified.

Many have failed at this point of the treatment and through no fault of theirs. Requeening is sometimes done with purchased queens and unfortunately not all queens are Italians which are sent out under that name and, further, not all Italians are equally good at cleaning out European foulbrood.

Doctor Miller has, with good results, practised caging the queen in the hive. Like results may be had by anyone under like conditions, which are exceedingly strong colonies, vigorous bees and a small amount of infection in the hive. This method appears questionable, since it may safely be assumed that the bees of a colony which is attacked by foulbrood have a susceptibility to disease which should be bred out. However, substituting a young queen reared from selected disease-resisting stock cannot be other than beneficial.

Other Modifications of the Same Principles

Instead of deposing or caging the reigning queen success is also had in combating this disease by causing the bees to construct a new brood nest, thus bringing about a period of no brood-rearing in the infected combs. There is no reason to expect success with this plan unless there is a heavy honey flow at the time. The principle appears to be the two or three days' break in egg laying reduces the food for the bacillus, the honey flow furnishes an abundance of healthful food for the larvæ and gives a stimulus to the cell cleaners and the cells which

contained diseased larvæ are quickly and thoroughly prepared for the incoming nectar.

The actual operation is to put the queen in a hive with full sheets of foundation, over this an excluder and the diseased combs over all.

The activity of the bees in cleaning out European foulbrood during a nectar flow from buckwheat has often been remarked. This has been accounted for by the supposed presence of a large amount of acid in buckwheat nectar. Acting on this theory some have fed a mild acid to diseased bees and reported good results.

Latham[1] in 1915 did much to bring this into prominence although Cushman[2] suggested it in 1890. Latham's plan is to give the infected colony a daily dose of lemonade. This is made of 10 ounces of sugar, the juice of one lemon and one-half pint of water.

Since it is an established fact that a honey flow (natural or artificial), often causes European foulbrood to disappear, the effectiveness of the lemon juice has been questioned and it has been suggested that a daily feed of syrup would be equally effective.

To avoid the trouble of making the lemonade one beekeeper has used an ounce of citric acid to a gallon of syrup and claims good results. Further testing is needed to prove the value of the acid treatment.

Exception has been taken to recommending the Alexander plan to all persons having bees, it being considered practical for advanced beekeepers only. There is some ground for this objection, but it is believed that anyone with sufficient skill and knowledge of beekeeping to successfully treat a colony with European foulbrood by the shaking plan will be equally successful with the dequeening method. Further, since less work is involved it is often easier to get the beekeeper to do the work.

On the other hand, it must be admitted that a host of bee-owners will fail with either treatment and the only remedy which is effective in their hands is the destruction of the colony.

PROBLEMS OF BEE INSPECTION

By Frank C. Pellett, *Atlantic, Iowa*

I must confess that I have modified my views concerning bee inspection each year of the five that I have served as state inspector of apiaries of Iowa. New difficulties have presented themselves each season, while some of the former ones have become simplified. I have at last concluded that we have been working along wrong lines and

[1] Latham, Allen, 1915, Gleanings in Bee Culture.

[2] Cushman, Samuel, 1890, Bulletin No. 9, Rhode Island Experiment Station.

that the plan now in operation in most states is not calculated to bring the best results with the small appropriations available.

In the beginning the appearance of bee diseases known as foulbrood was a matter of grave concern to the beekeeper. Little was known about either form, and methods of control were not certainly understood. Practical men had found that by removing the bees to a new and clean hive and destroying the old combs, including brood and honey, the infection was frequently eradicated.

The beekeepers were poorly organized and were slow in bringing their needs to public attention. As a result, both European and American foulbrood had spread into most of the northern states, before a serious attempt at control was undertaken. All the laws for the control of bee diseases with which I am familiar are similar in their general provisions. The sole idea seems to be to give a state officer authority to examine all the colonies in localities where disease is known to be present, and, by the use of a rigid quarantine, insist on the treatment or destruction of the diseased colonies. Had prompt and decisive action been taken when the trouble first appeared, it might have been stamped out as foot and mouth disease seems to have been.

The first and greatest difficulty which an inspector is called upon to meet, is to cover thousands of square miles of territory in which are located thousands of colonies of bees, with an appropriation not sufficient to cover 20 per cent of the territory efficiently.

Next to the lack of funds with which to follow the directions laid down in the law, the great problem is to get men who are sufficiently familiar with bee diseases and who have had sufficient experience in dealing with the public to enable them to do efficient work. In most states the work is paid for on a per diem basis. There is a rush of work for a few weeks during the honey producer's harvest and nothing to do the rest of the year. Since a man who is competent to do the work of an inspector can make several times as much for the same time spent, in an apiary of his own, it is necessary to be constantly educating young men who are willing to spend their vacations in this work for the experience gained. One who has not been responsible for such work under such conditions can hardly realize the amount of irritation that is constantly arising because of mistakes of one kind or another. As soon as a man becomes trained to do the work in an efficient and satisfactory manner, he is sure to find a more attractive opening elsewhere.

Much tact is required to deal with men who know little about bees and care less. In the average locality where inspection is new, the inspector will find men who don't believe that bees are subject to any

such disease as foulbrood; men who defy his authority and dare him to come on the premises; men who regard the inspector as a grafter and believe that the office was created by the politicians for the purpose of providing him with a job, and last, and often rather infrequently, men who want to learn something about the bees and who welcome the inspector with open arms. If all were like the last named, inspection would be a real joy, but to convince the others that it is to their interest to take advantage of the services of the inspector and that they will not suffer because of his presence requires much diplomacy. A man must never be in a hurry, must never be arbitrary, yet must be firm. I have become fully convinced that the police powers for the purpose of enforcing the provisions of the law should be in the hands of some other officer. The mere fact that the inspector is given so much power adds greatly to his difficulties. Knowing that if disease is found the inspector is given authority to demand the destruction of the diseased colonies makes the uninformed dread his coming and place every possible obstacle in the way of having the bees examined.

I might very easily extend this paper to great length by outlining in detail specific instances of such problems as above enumerated, but the facts will be too apparent to require extended discussion. The real problem after all is to find a remedy that will meet the trying conditions. There seems to be little of permanent value in the work of the inspectors aside from the education that comes to the individual beekeepers as a result of the personal contact. Even though sufficient appropriations of funds and trained men could be secured to stamp out foulbrood from any single state, the chances are that it would not remain free from the contagion for a single year. The fact that it is present in all the northern states and most of the southern ones as well, makes it improbable that the diseases can ever be permanently eradicated. It very frequently happens that an inspector will be congratulating himself upon the fact that by thorough work in a given locality he has cleaned up the disease, when lo! it suddenly appears again with a shipment of honey or bees from some outside location.

Since all are agreed that the problem is now one of education, why not make it an educational problem instead of a quarantine regulation? When an inspector goes into a locality and is required to examine all the bees there, entirely too much time and money is required, considering the limited resources available for the purpose. Apiary demonstrations such as are now held in Ontario under direction of Prof. Morley Pettit would seem to be much more efficient. If the beekeepers of the surrounding country are invited to spend a day in an apiary where disease is present, much more can be accomplished looking toward the control of foulbrood. All who take sufficient interest

to attend the demonstration can be shown disease in its various stages and also be shown how to treat each colony as its condition demands. Thus in one day ten to fifty persons can be given actual instruction in recognizing and treating disease, instead of spending the same amount of time in examining the colonies in one large apiary. Under present conditions the inspector does not have sufficient time to give each man visited sufficient instruction to enable him to care for the diseased colonies properly, and it often happens that the inefficient owner will not understand directions correctly and will succeed in spreading the disease instead of checking it.

In my annual report which has recently been filed with the governor, I have recommended that the present office of state inspector of bees, be abolished altogether. In its place I have suggested that a man be employed on full time in the extension department of the college of agriculture for the purpose of holding apiary demonstrations as above mentioned, during the summer months, and lecturing on marketing, production and other subjects of vital interest during the remainder of the year. I would not repeal the laws requiring proper attention to diseased colonies, and our proposed bill provides that the state apiarist can be called on petition of the beekeepers in any locality to examine bees which are supposed to be diseased. If he finds disease to be present, he is required to give the owner written instructions for the proper treatment or destruction, which instructions the owner is required to comply with within the time specified. However, the enforcement of this law is left in the hands of others, and he is not handicapped by being required to see that his own instructions are followed.

According to this plan it is hoped that by paying a salary for full time, a competent man can be secured for the work. By making his work purely educational in character it is hoped that he will be able to reach many more people, and to avoid the prejudice which is apparent under the present law. I realize that this plan is not perfect and that valid objections may be raised, but in a state like Iowa where 50,000 square miles of territory must be covered, and where there are 30,000 beekeepers, big and little, I am convinced that far more can be accomplished with the small funds which can be secured for this work, than by the present plan. It is hardly within the province of the state to examine every individual colony of bees in localities where disease is present, any more than it is to examine every pig where there is an outbreak of cholera, or other animal disease. Quarantine methods are justified and necessary in dealing with some new malady which has not yet become generally spread, but it is a hopeless task to undertake to eradicate any widespread contagion by these methods. I am fully convinced that this plan will shortly be abandoned and educational methods substituted very generally.

THE RESULTS OF APIARY INSPECTION

By E. F. Phillips

The inspection of apiaries in the various states is unfortunately conducted according to many different systems and in some cases with little apparent system. This work cannot be cast in a mold, because of the wide divergence of conditions in the various bee-keeping regions of the United States, but it would seem possible to standardize the work to some extent by discussions in this association and elsewhere. To show the divergence more clearly, some of the differences in plans may be mentioned. In some states it is the policy to do intensive work by attempting to visit and advise all the beekeepers in a locality before the inspector leaves; in other cases inspection is made only on request and only a few beekeepers are visited on each trip from the central office. In some cases emphasis is placed on work with the individual beekeeper; in other states meetings and demonstrations are held to reach a larger number of beekeepers. In some states the supervising officer has a bird's-eye view of the situation throughout the state, made possible by adequate records and maps; in other instances the inspector has no such efficient records and wanders more or less aimlessly about, helping wherever he can but without a broad outlook. To obviate some of the grosser errors, the Bureau of Entomology has advised supervision of the work by an already existing office, not only to save administration expense, but especially to make the work constructive, comprehensive and efficient. The history of inspection proves conclusively the advantage of such a system and shows the relative inefficiency of an independent inspector.

The title of the present paper indicates a desire to know whether the apiary inspection is profitable. At the request of beekeepers, the various states are spending thousands of dollars annually in this work. It has been in operation on an ever increasing scale since the first law was passed in Wisconsin in 1897 and enough experience is available to warrant the demand for a showing of results.

If conclusions are based on observations of a general character, one must believe that inspection is a decided benefit. Even in those states where there is little or no system and where the most careless work is done, we find individual beekeepers aided to better beekeeping and enabled to combat disease with success. The making of one good beekeeper in a county may result ultimately in greatly increased wealth to the state, so that one cannot easily measure the economic value of such work. In spite of valid criticisms, and there is abundant

room for criticism in various states, we must conclude from such an examination that apiary inspection is economically sound and that the expenditure is warranted.

But, so far, the general approbation of the work has been based on just such general observations, without analyzing the situation carefully. It is now well, after twenty years of trial, to examine at least some of the available data to make the criticism more valuable. Such an examination cannot be made comparative because of the divergent systems just mentioned and often because of lack of available records. It is entirely just to conclude that where intelligible records are lacking the work is least valuable. To analyze all the available data is an enormous task, which cannot be undertaken at present, but a few specimens may stimulate the administrative offices in this work to apply this test, and it is hoped that the analyses will be published. These results should be announced, even though the results are not all that might be desired, and if possible the results should be interpreted. This is the type of comparison and tabulation which the author recommended to this section at the annual meeting in 1915.

In the Mohawk Valley, New York, European foulbrood broke out in 1894 but it was not until 1899 that apiary inspection was established, as a result of the efforts of the organized beekeepers. The inspectors made an effort to determine the loss in colonies actually destroyed by disease, and, while this record is probably incomplete, they found that colonies valued at $39,487 were reported as lost. In 1899 (the first year of inspection) and successive years to 1904, the loss of colonies that died was given in the 1904 report as follows:

1895–1899	$39,487
1899	25,420
1900	20,289
1901	10,853
1902	5,860
1903	4,741
1904	2,220

When we consider the fact that in 1900 diseased colonies numbering 7,253 were found (valued at perhaps $40,000), it is evident that the disease was spreading with great rapidity and the State of New York made a good investment in establishing inspection whereby the percentage of diseased colonies was forced down from 23.9 in 1900 to 3.6 in 1905. About that time other outbreaks occurred but the per cent of colonies diseased has remained low.

Perhaps a better but less definite indication of the way in which, through inspection and education, the epidemic has been turned to the advantage of the beekeepers is in a comparison of past and present

conditions in the Mohawk Valley. It appears that before the outbreak of European foulbrood there were comparatively few extensive beekeepers in the valley and many uninformed and indifferent small holders. No inspection or educational system yet devised can save the careless beekeeper and it is unsafe to attempt too much along that line, but through the efforts of the inspectors and other educational sources, the careful beekeepers and those who would make an effort to clean up the disease were instructed in the diagnosis and treatment, so that today they have little fear of European foulbrood. There are probably fewer beekeepers than formerly but undoubtedly there are more colonies of bees and the average annual crop is larger than before the epidemic. The epidemic has thus been turned to an actual benefit to the industry through inspection.

In northwestern Indiana, European foulbrood is prevalent and has probably been present for many years. In the eastern portion of the state, American foulbrood is abundant and has caused enormous losses. On a brief trip of inspection, which the author took with Mr. George S. Demuth, then chief apiary inspector, but now in the Bureau of Entomology, several apiaries in the European foulbrood territory were found in which every colony was diseased.

In 1909 apiary inspection was instituted in Indiana under the supervision of the state entomologist. Of the 6,036 colonies examined that year 23.7 per cent were diseased and in Porter County 66.5 per cent of all colonies inspected had European foulbrood. The highest record for the prevalence of American foulbrood so far recorded is for Randolph County, Indiana, in 1910, where 83.5 per cent of the 3,000 colonies examined were diseased or dead.

To determine the results obtained through inspection, Mr. Demuth has kindly drawn up the accompanying table from part of the Indiana inspection records for the years 1909, 1910 and 1911, when he was doing the inspection. Counties were selected where inspection had been carried on in two successive seasons, and separate counts were made of those apiaries which were reinspected the second season. The revisited apiaries were usually those owned by beekeepers who, in the judgment of the inspector, were probably most in need of assistance and stimulation.

It may not be entirely clear why an entire county should show a decrease in the percentage of diseased colonies when only a part of the beekeepers had been visited, as was the case. This is doubtless due to the fact that the instructions of the inspector have been passed on to other beekeepers, indicating that the benefits of inspection are wider than might at first appear. It is also gratifying to see that in the reinspected apiaries there is usually a gain in the number of colonies amount-

TABLE OF INDIANA INSPECTIONS

Indiana	Total Inspection						Apiaries reinspected successive years						
County	Colonies examined		Colonies found diseased		Per cent of disease		Colonies examined		Colonies found diseased		Per cent of disease		Prevailing disease
	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	
Cass	87	13	38	1	43.9	7.7	15	15	3	0	33.	0	E. fb.
Daviess	117	171	8	7	6.8	4.+	59	72	5	4	8.4	5.5	E. fb.
Hancock	33	54	25	12	75.7	22.2	0	0	0	0	0	0	A. fb.
Jefferson	256	250	71	13	27.7	5.2	165	168	57	12	34.5	7.1	A. fb.
Lake	270	130	163	32	60.3	19.6	104	66	87	8	83.6	12.1	E. fb.
Marion	189	197	42	3	22.2	1.5	70	73	27	3	38.5	4.1	A. fb.
Newton	209	83	68	18	32.5	21.8	32	13	30	12	93.7	92.3	E. fb.
Pike	66	69	20	8	30.3	11.5	63	33	20	5	31.7	15.4	E. fb.
Porter	508	687	348	265	66.5	38.5	428	470	305	184	71.	39.1	E. fb.
Jasper	625	306[1]	278	27[1]	44.3	8.8[1]	173	246[1]	99	37[1]	51.4	10.9[1]	E. fb.
Total	2360	1960	1061	386	45.	19.6+	1109	1156	633	265	57.+	22.9	
Dividing counties according to prevailing disease													
E. fb.	1882	1459	923	358	49.+	24.5	874	915	549	250	61.6	27.3	
A. fb.	478	501	138	28	28.8	5.5	235	241	84	15	35.7	6.2	

[1] No inspection was made in 1910 in Jasper County and the results of the work in 1911 are here given instead. Since the results are comparable the figures for this County are included in the totals.

ing to about 5 per cent in all. A decrease from 45 per cent to 19.6 per cent in one year is certainly a high commendation of the efficiency of the work.

In this state, not only is the percentage of diseased colonies being reduced, but the beekeepers are finding out what their trouble actually is and beekeeping conditions are rapidly improving. It will take strenuous and continued inspection and encouragement to put the business on the footing which it should occupy, but the short time so far spent in the work shows that here too the epidemics may ultimately be instrumental in making better beekeepers and thereby be an indirect benefit. In Randolph County, where 83.5 per cent of the colonies in 1910 showed American foulbrood, conditions have materially changed. The data are not at hand but Mr. D. W. Erbaugh is responsible for the statement that at present American foulbrood is scarce and the beekeepers in that territory are increasing their apiaries and are finding beekeeping profitable. This is the most striking result of the Indiana inspection, even though no work was done there between 1910 and 1916.

Through the courtesy of Mr. E. G. Carr of the New Jersey inspection service, I am able to give data concerning the percentage of infection in Salem, Cumberland and Cape May Counties, New Jersey, in 1913 and 1915.

County	A. fb. 1913	A. fb. 1915	E. fb. 1913	E. fb. 1915
Salem	3.3	0	5.9	2.5
Cumberland	0	0	16.9	10.1
Cape May	0	0	34.7	8.4
Total	1.4	0	16.7	6 2

It is interesting to note also that in this territory in 1913 there was European foulbrood in 30.2 per cent of all apiaries inspected and American foulbrood in 3.8 per cent. In 1915 no American foulbrood is recorded and European foulbrood was found in 25.9 per cent of the apiaries. Of course the per cent of apiaries showing disease cannot be decreased as rapidly as the per cent of infected colonies. During the two years the number of colonies increased from 836 to 1,136, a gain of 35 per cent, which is the true test of efficiency. The plan in New Jersey is to cover a county as completely as possible before leaving it.

In Connecticut in 1910 there were inspected 1,595 colonies, of which 49.6 per cent were diseased and disease was found in 76 per cent of the apiaries. Without giving the data for the intervening years, it may

simply be recorded that the records for 1916 show 3,898 colonies inspected, of which 7.05 per cent showed European foulbrood and 0.15 per cent showed American foulbrood. European foulbrood was found in 18.8 per cent of the apiaries and American foulbrood in 1.07 per cent.

Obviously, changes in inspection policy and the routine methods of the work will influence these figures. For example, in Connecticut inspection was formerly done only on complaint and this restriction has been removed. However, from the figures given for these four states there can be no doubt of the economic value of the apiary inspection.

It will be noticed that in the four states chosen the apiary inspection is under the supervision of a central office, in three cases that of the entomologist. In making a study of the available data to obtain material for this paper, the records were studied of a number of states where this supervision is lacking. In no such case did such a benefit appear as in the cases chosen. Usually the data are more faulty. There is not observed such a consistent gain, and in some cases no gain whatever is observed. Therefore, it must be admitted that the instances chosen are not truly representative. It is not known whether the best records have been chosen, but they are certainly among the best. The data must therefore be interpreted as showing what can be done under good management. Every effort should be made to improve the inspection service in some of the states and this can, perhaps, best be done by publication of the results of inspection, as was recommended at the last meeting of this section. The inspection must also be improved by dicontinuing, so far as possible, the payment of inspectors only for days spent in the work, which too often means for days when they are not otherwise occupied.

The title chosen for this paper may be assumed to be covered by the type of data given, but at this opportunity it may be well to enlarge the discussion by way of pointing out a method of overcoming some present defects. As is well known, the Bureau of Entomology has during the year begun extension work in beekeeping, in coöperation with the regular extension offices. So far this work is confined to the Southern States. When it is considered that the value of inspection comes chiefly from the efficiency of the educational feature of the work, it will be seen that, in a sense, extension work is but a continuation of what has been done for years in some states. However, an extension worker is freed from the odium of police power, which is at times a detriment to the inspection work. Since in perhaps half the states the apiary inspection is below its possible efficiency, and, since without unwarranted interference this cannot well be changed, except by the

beekeepers of the state who often fail to recognize the poor quality of the work, it is pertinent to suggest that extension work should replace at least the incompetent inspection, or, if it is possible, supplement and stimulate it.

The future of the beekeeping industry depends in no small measure on the creation of professional beekeepers. Apiary inspection was instituted chiefly to save what already existed and was not conceived as a creative agency. If inspection is to assist in giving the much needed impetus to the industry, every apiary inspector should emphasize the extension features of his work, so far as his authority will permit, and in addition should encourage and support the extension work which openly assumes the task so long carried unannounced by the inspection. By enlarging the extension work to the fullest extent we may expect still more satisfying results than those here tabulated.

Section on Horticultural Inspection

The Fifteenth Annual Meeting of the Section on Horticultural Inspection was held in New York City on December 27 and December 29, 1916, respectively.

Fortunately, a "joint session" of the American Phytopathological Society and the American Association of Economic Entomologists was arranged for Wednesday, December 27, 1916, at 9.30 a. m. in Barnard College, for a conference on two dangerous imported plant diseases which have become established in the United States, and are assuming threatening proportions, viz., the citrus canker and the white pine blister rust. This "joint session" proved so profitable and interesting that an attempt will be made at future meetings to arrange for at least one "joint session," for the consideration and discussion of new insect pests and plant diseases. The entomologists and horticultural inspectors present at this meeting received the very latest advice concerning important phases of these diseases, their development, the rapidity and possibility of spread and possible methods of control and eradication.

An invitation to attend the sessions was extended to the legislative committee of the National Nurserymen's Association and to Mr. Curtis Nye Smith, of Boston, Mass., Secretary and Counsel of this Association. Mr. William Pitkin, of Rochester, N. Y., chairman of the legislative committee; Mr. J. M. Pitkin, of Newark, N. Y.; Mr. J. H. Dayton, of Painesville, O., attended the sessions and conferences.

PROGRAM

Joint Session

American Phytopathological Society.
American Association of Economic Entomologists.
Section on Horticultural Inspection.

CONFERENCE ON PHYTOPATHOLOGICAL INSPECTION AND QUARANTINES

Wednesday, December 27, 1916, 9.30 a. m., Room 139, Barnard College

Aims and Methods of Pathological Inspection—F. R. Lyman, Washington, D. C.

New Foreign Pathological Quarantines and Restrictions—R. K. Beattie, Washington, D. C.

Citrus Canker Investigations at the Florida Tropical Laboratory—R. A. Jehle, Miami, Fla.

The Present Status of Citrus Canker Eradication—K. F. Kellerman, Washington, D. C.

The Present Status of White Pine Blister Rust in North America—Haven Metcalf, Washington, D. C.

Evidence of the Over Wintering of *Cronartium ribicola*—Perley Spaulding, Washington, D. C.

The Control of White Pine Blister Rust in Small Areas—W. H. Rankin, Geneva, N. Y.

The Committee for the Suppression of White Pine Blister Rust in North America: —Purpose, Personnel and Program—J. G. Sanders, Harrisburg, Pa.

Second Session

Friday, December 29, 1916, 2.00 p. m., Teachers' College

Business—Election of Chairman and Secretary for 1917

1. The Weakness of our Present System of Inspection of Foreign Shipments—W. J. Schoene, Blacksburg, Va.
2. Activities of the Federal Horticultural Board at the Port of New York—Harry B. Shaw, In Charge of New York Port Inspection.
3. Important Foreign Insect Pests Collected on Imported Nursery Stock in 1916—E. R. Sasscer, Washington, D. C.
4. The State Entomologist's Work with Pine Blister Canker in Minnesota—F. L. Washburn, Minneapolis, Minn.
5. Potato Inspection in Minnesota—F. L. Washburn, Minneapolis, Minn.
6. Discussion—How Are We Aiding Nurserymen by Enforcing Sanitation of Adjacent Premises?

Reports of Methods Employed in Various States.

Third Session

Friday, 8.00 p. m., American Museum of Natural History

A Symposium on Existing State Horticultural Inspection Laws.

An Open Round Table Discussion—Led by Mr. William Pitkin, Rochester, N. Y., Chairman legislative committee, American Association of Nurserymen, and Mr. Curtis Nye Smith, Boston, Mass.—Counsel and Secretary, American Association of Nurserymen.

Second Session

The second session of this Section was called to order in Teachers' College, at 2.15 p. m., Friday, by Dr. W. E. Britton, who was elected chairman *pro tem.*, in the absence of Prof. W. J. Schoene. After a short business session Prof. G. M. Bentley, Knoxville, Tenn., was elected chairman for 1917, and Prof. J. G. Sanders, Harrisburg, Pa., was reëlected secretary. By official action the name of the body was changed from the original title—"The American Association of Official Horticultural Inspectors"; and the title, "Section of Horticultural Inspection" of the American Association of Economic Entomologists was adopted for future use.

Third Session

The third session of this Section was held in the American Museum of Natural History on Friday, December 29, at 8 p. m. This meeting was a radical departure from anything previously held, in that it was turned over to the representatives of the National Nurserymen's Association present at the meeting.

Mr. William Pitkin, of Rochester, N. Y., opened the meeting with a short resumé of the remarkable and happy advances which have been made in horticultural legislation, and in the better mutual understanding of the problems of the nurserymen and the inspectors. During the last five or six years, he said, through several conferences and official meetings many knotty problems had been threshed out, pertaining to nursery inspection and the handling of nursery stock. He spoke in a very happy vein of the more candid relationship which had been generated in the nurserymen and inspectors by these occasional meetings, and hoped that the future would bring about even more satisfactory results. Mr. Pitkin thanked the inspectors on behalf of the Nurserymen's Association for the invitations and privileges which have been extended to them.

At this point Mr. Pitkin gave way to Mr. Curtis Nye Smith, secretary and counsel of the American Association of Nurserymen, who opened the discussion on "Some Existing State Horticultural Inspection Laws" from a standpoint of legality and constitutionality. Mr. Smith's clear and concise statements and explanations concerning the legal phases of horticultural inspection laws were indeed educational, and served to clarify a number of rather intricate legal problems in horticultural inspection.

Hearty discussions were engendered, and much information was brought forth regarding the requirements of certain states in their horticultural laws, which from a legal standpoint seemed to be unconstitutional and confiscatory in nature.

Mr. Smith discussed at some length what consummated a "sale," and where and when the sale of stock was completed, the order for which had been taken by an agent in another state. It is unfortunate that a larger number of our horticultural inspectors of the country could not have been in attendance at this session.

THE COMMITTEE FOR THE SUPPRESSION OF PINE BLISTER IN NORTH AMERICA: PURPOSE, PERSONNEL AND PROGRAM

By J. G. Sanders, *Harrisburg, Pa.*

The recent formation of an enlarged unofficial committee for the purpose of uniting the efforts of the various states and Dominion Provinces with the Federal and Dominion Governments to control and prevent the further dissemination of the dangerous blister canker, which threatens to wipe out the white pine industry of the North American Continent, is a most praiseworthy effort.

It is not necessary at this time to review fully the past history of this committee, but it is well to note that the movement originated in Massachusetts, where the extremely dangerous nature of the disease was first observed in its destructive stages. Officials of the Massachusetts Forestry Association,—particularly Mr. Harris A. Reynolds and Mr. William P. Wharton of Boston—have been largely instrumental in continuing this effort, which has now resulted in a nation-wide movement.

On November 20 and 21 this year, on invitation, this committee, with several additional state officers invited, met at Albany, N. Y., and appointed committees for the consideration of questions which immediately arose. Reports from various states where infections had been found were received, and the infected areas graphically illustrated by maps and charts. There is no doubt but that these reports revealed an alarming condition in the eastern United States, and the consensus of opinion at the meeting was that immediate, powerful and drastic efforts should be made before another summer, to safeguard the western pine interests, and to control the disease in the eastern United States where infections occur.

Scouting on a very much greater scale was deemed advisable, the burden of this work, however, is to be undertaken by the Federal Government; the clean-up and follow-up work to be performed largely by the state officials in coöperation with the Federal Department.

Resolutions dealing with various questions of control and eradication were adopted, the most important, however, being the promulgation of

two bills in the United States Congress. It was thought advisable that a bill be immediately introduced and passed during the coming session, if possible, absolutely prohibiting the shipment of 5-leafed pines and all species of Ribes beyond the quarantine line, which should be indicated as the western border of Minnesota, Iowa, Missouri, Arkansas and Louisiana, and that in enforcing this quarantine the Dominion Government would coöperate to the mutual advantage of each government.

A second bill which was deemed advisable for passage is one in which the Federal Government is to prohibit the importation of all nursery stock as defined under the present rules and regulations of the Federal Horticultural Board, except that the Department of Agriculture may import, grow and propagate, under proper quarantine conditions, for experimental and scientific purposes, such nursery stock that is deemed desirable by said department. Bills for these purposes are to be given further consideration and discussion at the annual meeting of the American Forestry Association in Washington, D. C., January 18–19.

An indication of what the enlarged committee may succeed in doing is the success attending the efforts of the original committee in securing $50,000 from the Federal Congress to promote the work during the past year. It is reasonable to believe that with the coöperation of all the members of this enlarged committee much more efficient work may be carried on, with a very much increased appropriation. Naturally, the campaigning efforts of the committee will lend weight to argument in the state legislatures for support, and in this way much mutual assistance may be had.

The personnel of the enlarged committee has been determined by resolutions, which were adopted, allowing not to exceed four members from each state and Canadian province where white pine is growing. These four members in the various states were to be appointed from six sources deemed most advisable, viz., the state forestry association, a lumbermen's association, state department of agriculture, the agricultural experiment station, the agricultural college and the officer having charge of the enforcement of the horticultural inspection laws. From these sources it was thought that four very efficient and deeply interested representatives could be appointed for this enlarged international committee. The selection of these officials is underway at this time, and the complete personnel of the committee will doubtless be announced shortly.

An executive committee of three was selected at the Albany meeting, and consists of Mr. William P. Wharton of Boston, chairman, E. C. Hirst, state forester of New Hampshire and J. G. Sanders, economic zoölogist of Pennsylvania.

The program of the committee has been outlined in a degree, but

the most important matter which must be taken up immediately by the several state committee members, is the passage by the legislatures of horticultural inspection laws of sufficient and inclusive power to permit the official in charge to proceed with all necessary speed to check this disease. Sufficient funds should be secured in order to coöperate fully with the Federal Department and follow up their scouting work in the suspected districts. The time for immediate action is here, and I can not impress upon the members of that committee too strongly the importance of taking this matter to heart, and acting upon it before another summer has elapsed. The experience of last summer, in which the disease was spread broadcast—in some cases, as far as we can judge, advancing several miles in all directions from infected localities—is sufficient warning to the thoughtful scientists and officials.

All the energy, influence and power which the members of this committee have at their command should be exercised in assisting in the passage of the bills previously mentioned through our Federal Congress. Furthermore, it is necessary that the members of this committee exert their influence and extend their moral support to the Federal Horticultural Board, in their campaign for the control of import shipments and the establishment of quarantines. It is believed that if the Federal Board fully realized the feeling of the officials and citizens of a larger number of our middle and western states, they might take more drastic action upon certain fundamental questions than they have in the past. Unfortunately, our state officials and inspectors have not been so careful to appear before the Federal Board hearings as have the members of the nurserymen associations and the brokers, to express their views on horticultural matters. Consequently, the Federal Board has had the burden of testimony oftentimes on the side which has not appeared entirely satisfactory to our state officials.

It now remains for the members of this board, who have been honored by selection and appointment, to coöperate fully with the executive committee, chairman and secretary, so that the best result may be quickly secured.

We are most happy in knowing that the American Forestry Association have promised to assume all expense and responsibility in pushing the publicity campaign without which we will be almost helpless. This Association, through its president, Mr. Charles Lathrop Pack, of New York, and Mr. P. S. Ridsdale, editor of *American Forestry*, Washington, D. C., promises its efforts in promulgating the desired legislation in the Federal Congress, and also its assistance wherever possible and desirable in state legislation.

As one of the executive members of this committee I wish to express our keen appreciation of the kindness of the American Forestry Association in this campaign.

THE WEAKNESS OF OUR PRESENT SYSTEM OF INSPECTION WITH REGARD TO FOREIGN SHIPMENTS

By W. J. Schoene, *Blacksburg, Va.*

These remarks are not intended to apply to conditions in any one state, but rather to the whole country, and to refer more especially to past events and future happenings. Owing to the peculiar dual form of our government, each state has authority, so far as injurious pests are concerned, to regulate or not to regulate its internal affairs in any way its citizens may desire; and entomologists, who have been laboring for the development of our inspection work and the enactment of crop pest legislation, have always had this fact to contend with; for, as we are fully aware, state lines do not function as barriers to the spread of injurious pests. The policy of one state has frequently been radically different from its neighbor. One state may promulgate stringent rules to control or to suppress an injurious pest, while other states may either refuse to act or else adopt the policy of letting nature take its course. The result of such policy, so far as the spread of injurious pests are concerned, is obvious.

As a specific instance of the condition just mentioned, there are certain states, which some years ago were believed to be free of San José scale, and which provided themselves with adequate inspection machinery to protect their fruit industry; while in other states in which the presence of this insect was a matter of common knowledge, only scant appropriations were made for inspection work; or, as has happened, the best horticultural authorities actually opposed inspection legislation.

As history repeats itself, so the history of the spread of the San José scale and of the attending diversity of laws will be repeated, in modified form, with the appearance of each important pest. Take, for instance, the white pine blister rust, authorities are by no means agreed either as to the best means of handling the problem or what the situation demands.

In considering the inspection of foreign shipments of plants, which is certainly the most important problem confronting American entomologists today, we find some diversity of opinion. This is especially true when we compare the ideas of the importer or the buyer with those held by some of our entomologists. The importer, as well as the buyer, looks upon the trade in foreign stocks as an ordinary commercial proposition and a large business has been built up in this class of goods because ornamental and fruit stocks can be produced cheaper, and perhaps better, abroad. This traffic is being continued, in spite of the protest of a few entomologists, although the United States is the only great nation that opens its doors to almost unlimited importations of

living plants. The danger is recognized, but entomologists are not entirely of one accord and, doubtless, the officials of the Federal Horticultural Board could tell us that the inspection of importations of stock is considered a much more serious matter in some states than in others.

Another unquestioned obstacle to the successful prosecution of inspection work in America, as well as greater restriction of foreign shipments, is the interference by persons having legislative authority. There is probably no state in which inspection officials have not at one time or another felt such influence. The writer had occasion to attend a meeting called by the Federal Horticultural Board to discuss a domestic quarantine. At this meeting there were several congressmen present representing the districts in question, and the writer understands that this is not unusual. Whether or not the members of the Federal Board have ever been embarrassed by representative congressmen, of course, can be answered only by members of the board. However, it may be asserted positively that the powerful nursery interests of this couutry are thoroughly organized and always ready to maintain a lobby to protect their interests.

Then, to conclude, we have on the North American continent, Canada, Mexico, and the states and territories comprising the United States, fifty or more sovereign powers; each making its own laws, each law different and each inspection official with a different idea. And yet, there are no natural barriers to limit the spread of an injurious species, transportation lines of one sort or another touch every part of the continent; and once established, it is only a question of time until every disease or insect will reach the remote parts of the continent in spite of all quarantines and restrictions imposed.

Because of the peculiar organization of our government, and the powerful commercial interests that are able to influence legislation, inspection officials should band themselves together and act as an organization for the purpose of securing more stringent regulations regarding the importation of plants from foreign countries and greater uniformity in the treatment of our domestic problems.

THE ACTIVITIES OF THE FEDERAL HORTICULTURAL BOARD AT THE PORT OF NEW YORK

By Harry B. Shaw, *New York, N. Y.*

(Abstract)

The activities of the Federal Horticultural Board at the Port of New York are for the most part connected with the practical application of the provisions of the Plant Quarantine Act to the quarantines in force. With few exceptions contact is made at this port with all current plant quarantines.

The secretary of agriculture and the secretary of the treasury, by the provision of the Quarantine Act, coöperate through the custom service in notifications of receipt of plants from abroad. This extensive coöperation involves directly or indirectly nearly 3,000 customs employees.

The writer, appointed in April, 1914, as representative of the Federal Board at this port, has been in close association with the custom service, and has learned the various avenues of receipt and the methods of guarding the various importations. Entry clerks scrutinize the invoices and records and number the entries and assess the duties. In the case of imported plants the entry clerks require the importer to furnish certificate of inspection from the country of origin. Irregularities, such as lack of certificates of inspection and permits, are referred by the entry clerks to the pathological inspector for instructions. All entry of nursery stock from countries not listed as operating an inspection service are opened at the docks, or in public stores, for immediate inspection.

Through the instrumentality of delivery permits and the custom inspectors we are able to prevent the release of nursery stock until all requirements have been met.

Small personal importations of nursery stock are handled through the appraiser, and are examined after having received notification from this officer. Frequently plants which are brought in as baggage by passengers arriving from all parts of the world are discovered, and inspected by authority of the surveyor of the port. Notices in printed form for distribution to passengers, warning them concerning the importation of living plants, have been distributed, and these doubtless will soon reduce the number of importations by passengers.

Importations of potatoes entering this port in 1913–14 were inspected to ascertain the presence of powdery scab and potato wart disease. These arrived by the thousands of sacks and crates from Holland, Belgium, Denmark and Sweden. Powdery scab was discovered in numerous shipments, as well as an abundance of the more common potato diseases. No evidence of potato wart, however, was discovered.

Since the outbreak of the European War the importation of potatoes has entirely ceased. In the meantime powdery scab was discovered in Maine, and Quarantine No. 14 was issued, prohibiting the movement of potatoes from that state excepting after Federal certification.

Attempts were made to ship potatoes from United States ports to Cuba and other West Indian points, and also to South America. Carelessness in selection of potatoes caused their arrival in some cases at points of destination in very poor condition, and our markets were thereby injured.

The inspection of cotton from foreign countries, on account of the pink boll worm danger was originally carried on at the dock, but after thorough fumigation became obligatory the dock inspection has been discontinued, and reliance has been placed on the thorough fumigation in large chambers which have been constructed by importing companies. Large quantities of old gunny sacks, burlaps and hessian, as well as much jute waste and shoddy wrapped in old cotton bale covers are imported. This fact being demonstrated the Board required that all burlaps, which had been used for covering cotton, should be treated before release.

Special disinfection plants have been erected to meet the requirements of the Federal Board, so that large importing companies now handle an immense quantity of material in a day. One company has erected two fumigating chambers of cylindrical form, 9 feet in diameter and 116 feet long, through which pass in a single day a large number of bales of imported cotton and other cotton waste materials.

In addition to the port of entry inspection other phases of activity, such as inspection of samplerooms and receptacles for storage of cotton samples, inspection of warehouses, factories and storerooms in New York and its vicinity have been carried out, in order to meet the requirements of the Federal Board attempting to prevent the introduction of dangerous insects and diseases.

(Numerous interesting lantern slides showing the New York port of entry, the large cargoes of various material to be inspected, the fumigation chambers and plants of certain firms and the inspection of potatoes, were thrown on the screen.)

IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IMPORTED NURSERY STOCK IN 1916

By E. R. Sasscer, *Washington, D. C.*

The fiscal year 1916 marked a slight decrease in the amount of nursery stock offered for entry by the five principal European countries exporting plants to the United States with the exception of Holland. Although the amount of nursery stock exported by Belgium, England, France, and Germany into the States during this period is somewhat less than in the fiscal years preceding, it will be noted from the table below that more plants were imported from these countries, except Germany, in 1916, than in 1913 or 1914.

As the result of State and Federal inspection the following insects have been intercepted during the calendar year: Egg masses of the gipsy moth (*Porthetria dispar* Linn.) were taken on five different occasions as follows: on beech and apple stock from France, on

Table Showing Amount of Nursery Stock Offered for Entry During the Past Four Years

	1913		1914		1915		1916	
	Nursery Stock	Seed, Pounds	Nursery Stock	Seed, Pounds	Nursery Stock	Seed, Pounds	Nursery Stock	Seed, Pounds
Belgium......	704,927		720,891	165,000	1,114,089		1,065,864	20
England	2,578,174		2,267,285		3,914,901		2,872,745	5,625
France.......	30,812,059		29,024,187	2,073	41,604,161	40,053½	38,202,978	30,210
Germany.....	1,360,398	7,020	194,186	1,049	177,994	821¾		82
Holland......	5,274,944		4,602,954		6,539,416	6	9,562,421	

Thuya and *Azalea* from Japan, and on rose from Holland. Nests of the brown-tail moth (*Euproctis chrysorrhœa* Linn.) were collected on five consignments from France. Egg masses of the European tussock moth (*Notolophus antiqua* Linn.) were repeatedly collected on stock from France and Holland, and pupæ of a dagger moth (*Apatela auricoma* Fab.) were reported on five shipments from France and one from Holland. *Gracilaria zachrysa* Meyrick has been frequently reported on azaleas from Holland, Belgium, and Japan. *Porthesia similis* Fuessly, a close relative of the brown-tail moth, was collected on rose in Georgia from Holland. The larvæ of this moth are found in small hibernaculæ and may be easily overlooked. This insect has a wide distribution in Europe, and has also been reported from China, Japan, and Korea. The Leopard Moth (*Zeuzera pyrina* Linn.) was collected in Ohio on Paradise apple stock from France. Dead larvæ of the pink boll worm (*Gelechia gossypiella* Saunders) were found in samples of China cotton enclosed in glass trays exhibited at the Panama-Pacific Exposition at San Francisco. Although every precaution was taken to safeguard this material by the California authorities, the finding of these dead larvæ forcibly demonstrates the possibility of introducing new and injurious pests in plant products exhibited at expositions.

In this connection it is of peculiar interest to note that the prize ship *Appam*, which was brought into Hampton Roads early in the year, contained as a part of its cargo some two hundred tons of cotton seed from Lagos, West Africa, a region known to harbor the pink boll worm. Although no living larvæ of the pink boll worm were located it was apparent, from the condition of the material, that about 2 per cent of the seed had at one time been infested with this insect. To safeguard the cotton interests of this country the entire consignment was converted into fertilizer by a Portsmouth firm, and the dock on which the seed had been unloaded was thoroughly cleaned and the ship fumigated with hydrocyanic-acid gas. The arrival of a quarantined product on a prize ship opens up a new avenue of entrance, and

had not the customs officials at Norfolk been familiar with the cotton regulations this consignment could have been officially entered, and in all probability would have received a wide distribution.

The mango weevil (*Sternochetus mangiferæ* (Fab.)), *Cryptorhynchus*, was collected in mango seed from Siam and Japan, and larvæ of what appears to be a new species of *Conotrachelus* were collected in avocado seed from Guatemala. *Prunus* seed from Japan received in Washington exhibited injury made by a species of *Anthonomus* closely related to *druparium*. Several dead adults and larvæ were taken. A pine prop used to support nursery stock in a container was found to exhibit galleries made by *Tomicus piniperda* Linn., one of the more destructive insect enemies of the pine in Europe. When received, many adults had emerged, and it is impossible to say whether they emerged before leaving Holland or after arriving in the States. Cocoons of a sawfly, *Emphytus cinctus* Linn., were intercepted on green ash cross sticks or props from England and on Manetti stock from France. Orchids from Venezuela and Colombia were frequently found to be infested with *Tenthecoris bicolor* (Scott). *Lachnus fasciatus* Burm. was collected on *Picea glauca* from France, and *Lachnus hyalinus* Koch was collected on *Picea excelsa* from France. An unrecognized species of *Lachnus* was collected on *Juniperus virginiana* from France. The box psyllid (*Psylla buxi* Linn.) was reported on thirty-three shipments of boxwood from Holland, and a white fly, *Aleurothrixus* sp., was taken on "Semilla de Molle" from Chile. Coccids have been reported on numerous occasions, some of the more important of which are the following:[1]

Aspidiotus tsugæ Marlatt on hemlock from Japan.

Aspidiotus subsimilis Ckll. on avocado from Guatemala.

Aspidiotus palmæ Morg. and Ckll. on cocoanut from Honduras.

Chrysomphalus personatus Comst. on orchid from Canal Zone.

Chrysomphalus perseæ Comst. on orchid from Mexico, Venezuela, Canal Zone, Colombia, and Panama.

Pseudaonidia articulatus (Morg.) on *Areca* sp. from Trinidad.

Pseudaonidia articulatus (Morg.) on cinnamon from Jamaica.

Pseudaonidia pæoniæ (Ckll.) on azalea, persimmon, camellia, and rhododendron from Japan.

Pseudaonidia duplex (Ckll.) on camellia from Japan.

Targionia biformis (Ckll.) on orchid from Canal Zone, Colombia, and Guatemala.

Targionia sacchari (Ckll.) on sugar cane from Antigua, B. W. I., and Cuba.

Pseudischnaspis bowreyi (Ckll.) on *Agave Wightii* from Jamaica.

Chionaspis wistariæ Cooley on wistaria from Japan.

Chionaspis sp. on chayote from Jamaica.

Epidiaspis piricola (Del G.) on apple (2) from France.

Lepidosaphes lasianthi (Green) on camellia (3) from Japan.

Lepidosaphes newsteadii (Sulc.) on umbrella pines (2) from Japan.

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[1] The number in parentheses following name of host indicate the number of times reported.

Lepidosaphes mimosarum (Ckll.) on *Anona cherimoya* from Guatemala.
Lepidosaphes sp. on *Agave* from Panama.
Lepidosaphes sp. on croton from Costa Rica (3).
Parlatoria chinensis (Marlatt) on flowering shrub from northern China.
Parlatoria crotonis (Douglas) on croton from Costa Rica.
Parlatoria calianthina (Berl. & Leon.) on olive from Greece.
Pinnaspis buxi (Bouché) on *Dracæna* from Jamaica.
Pseudoparlatoria parlatorioides (Comst.) on orchid from Brazil.
Conchaspis angracci (Ckll.) on orchid from Canal Zone.
Antonina crawii (Ckll.) on *Bambusa nigra* from Japan.
Asterolecanium aureum (Bdv.) on orchid from Isle of Pines and Canal Zone.
Eriococcus coccineus (Ckll.) on Echinocactus from Peru.
Lecanium bituberculatum (Targ.) on *Malus* sp. from Holland.
Orthezia cataphracta (Shaw) on *Iris setosa* from Newfoundland.
Pseudococcus bromeliæ (Bouché) on pineapple (3) from Trinidad.
Pseudococcus marchalii on *Mangifera indica* from Calcutta, India.
Pseudococcus sacchari (Ckll.) on sugar cane from Hawaii.
Pulvinaria pyriformis (Ckll.) on cinnamon from Jamaica.

In addition to the above, many insects of greater or less importance have been taken on various plants and plant products. All interceptions are listed in Letters of Information issued by the Federal Horticultural Board, and these letters are available to all inspectors.

The following list indicates, by countries, the number of species of insects reported by State and Federal inspectors during the calendar year 1916 up to and including December 16:

Holland	68	Straits Settlements	4
Colombia	51	Arabia	3
Japan	37	Greece	3
France	36	Madagascar	3
Belgium	25	New Zealand	3
England	24	Panama	3
Brazil	20	Russia	3
Cuba	19	Trinidad	3
Jamaica	12	Antigua, B. W. I.	2
Canal Zone	11	Bahama Islands	2
China	11	Eritrea, Africa	2
Venezuela	11	Guadeloupe, French W. I.	2
Guatemala	8	Haiti	2
India	8	Hawaii	2
Philippine Islands	8	Honduras	2
Bermuda	7	Newfoundland	2
Chile	7	Northern Nigeria	2
Costa Rica	7	Peru	2
Italy	7	Spain	2
Mexico	7	Turkey	2
Egypt	6	Argentina	1
Scotland	5	Azores	1
Australia	4	Canada	1
British Guiana	4	Ecuador	1

Isle of Pines	1	Senegal	1
Java	1	Seychelles	1
Natal	1	Siam	1
Paraguay	1	Sudan	1
Portugal	1	Turk's Islands	1
Santo Domingo	1		

APHID EGGS IN TEXAS (Lat. 30°, 30′)

By Hal C. Yingling, *College Station, Texas*

For some time the impression has existed that oviparous reproduction in aphids does not occur in the extreme southern portion of the United States. To quote F. M. Webster (Bureau of Ent. Bul. No. 110),—"In the South, seemingly south of about latitude 35° to 36° north, it has been impossible to find eggs of this (*Toxoptera graminum* Rond.) and other species of aphidids in the fields." Other papers have given the same impression, apparently based on the fact that no eggs had been found and the assumption that the egg stage was unnecessary for hibernation in warmer climates. As practically all of Texas lies south of 35°, the common impression has been that aphid eggs do not occur except in the northern part of the state.

On a collecting trip December 16, 1916, the writer found two rather large clusters of aphid eggs with wingless aphids in the act of oviposition, all under normal conditions for the locality. The eggs were packed closely together upon a single stem of dogwood (*Cornus asperifolia* Mich.), the two clusters being situated near the end of the twig, about three inches apart. Wingless females alone were found, huddled together on and around the masses of eggs, the weather being rather chilly.

The material was turned over to Prof. F. B. Paddock of the Texas Agricultural Experiment Station, who identified the aphid and host, also making a brief study of the habits. The aphid compares very favorably with the description of *Schizoneura corni* Fab.

Professor Paddock had the good fortune to watch the deposition of an egg by one of the females, the process being resumed when the aphids were introduced into the warm laboratory. The female backed up to the egg cluster to place the egg with the others, the whole process taking about forty-five minutes for completion. During this time the middle legs were held tightly folded under the body. The egg was deposited with its long axis perpendicular to the surface of the bark, but soon turned over and rested in a horizontal position. The material covering the egg was viscous enough to enable the aphid to use the egg as an anchor while placing the next egg.

When first deposited, the egg was a deep cherry-red, becoming dark brown in about fifteen minutes. Nearly an hour was required for the complete assumption of the black color. At the time of writing, the smaller cluster contains about one hundred eggs, while the larger one exceeds two hundred in number, the process of oviposition not being completed as yet.

Scientific Notes

Notes on Several Insects not Heretofore Recorded from New Jersey. *Janus abbreviatus* Say[1] (Hymen.). This saw-fly appears to be established at the following localities in New Jersey; Bound Brook, Rutherford, Irvington, Elizabeth, South Orange and Springfield, occurring as a rule in nurseries. The larvæ live in the twigs of poplar and willow trees and are generally found in those which spring from the base of the tree. Occasionally twigs higher up are infested. After the middle of summer, the infestation is readily noticed by the dying back and turning black of the tips of the shoots. At the present time, in New Jersey at least, it is more of a nursery than a shade tree pest.

Diprion simile Hartig (Hymen.). This species, known as the European pine saw-fly was found for the first time in New Jersey during the summer of 1916 at the following localities: Elizabeth, Rutherford, South Orange, and like the preceding species, its activities were confined entirely to pine trees in nurseries. It has evidently been present in New Jersey for the past several years and during the past season was rather heavily parasitized inasmuch as from two hundred cocoons, only eighteen adults were secured, the remainder bringing forth hundreds of specimens of *Monodontomerus dentipes* Boh.[2] In the June, 1915, number of the Journal of Economic Entomology, p. 379, there appeared a paper on this saw-fly by Dr. W. E. Britton.

Phytomyza aquilegiæ Hardy (Dip.). In some way or another, this species known commonly as the columbine leaf-miner, was omitted from Smith's List of the Insects of New Jersey. As a matter of fact, it is a local pest of columbine and has been noted at Springfield, Rutherford, Riverton and Elizabeth and undoubtedly has a much wider distribution. Mr. E. N. Cory in his paper on this species (Jour. Econ. Ent., vol. 29, No. 4, pp. 419–424) also mentions New Brunswick, which is an additional locality. The destruction of the infested leaves early in the season where practiced in New Jersey has been followed as a rule by a considerable lessening of the injury later in the season.

Blaberus discoidalis Serv. (Orthop.). This large attractive roach has been found several times in greenhouses in New Jersey, having been introduced with orchids imported from South America. According to Mr. Morgan Hebard, who identified this species, it is one of the commonest members of the genus through the West Indies, northeastern South America and as far northward on the mainland as Panama. Mr. Hebard treats of this species in his paper "Critical Notes on Certain Species of the Genus Blaberus," published in *Entomological News*, vol. 27, No. 7, pp. 289–296.

Harry B. Weiss, *New Brunswick, N. J.*

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[1] Identified by S. A. Rowher.

[2] Identity obtained from Mr. Crawford through Dr. W. E. Britton.

The Clover Weevil in Iowa. The following note on *Hypera punctata* in Iowa may be of interest taken in connection with the recent records of James W. McCollough (Jour. Econ. Ent. vol. 9, p. 455) in Kansas.

So far as I know the first record of this species in Iowa is a previous record of my own (Jour. Econ. Ent., vol. 3, p. 502) which reports its occurrence at Burlington in April, 1910. A year or two later Prof. H. F. Wickham collected it at Iowa City, although I believe no published record has been made of this. The insect was not brought to my attention in Iowa again until November, 1914, when I observed larvæ at Mount Pleasant, Iowa, about thirty miles west of Burlington, November 12. Two days later larvæ were seen feeding on clover at Davenport.

April 8, 1915, larvæ were observed fairly common on clover at Clarinda in southwestern Iowa. This was the first record in the western part of the state. April 21, 1915, I found it at Ames, in central Iowa; May 10 on alfalfa at Council Bluffs in extreme western Iowa; May 11 on alfalfa at Red Oak in Southwestern Iowa.

In northeastern Iowa larvæ were again observed on clover, May 11 and 12, 1916, at Dubuque, Bellevue and Cascade; nearby localities.

From these records it is likely that the insect occurs all through southern Iowa and probably most of eastern Iowa.

R. L. Webster.

Pink Boll Worm. November 1 specimens of cotton bolls showing the presence of *Gelechia gossypiella* were received at the Bureau of Entomology. They came from San Pedro de las Colonias, Mexico. This was the first record of the occurrence of this important pest in America. Investigation indicates that it was introduced into Mexico through Egyptian seed imported for experimental purposes. The first step taken to protect the country against this pest was an absolute quarantine on Mexican cotton seed and bales of lint, which became effective on November 4. All shipments of Mexican cotton seed which have entered the country since July 1 have been traced to their destinations and strong efforts are being made in coöperation with state officers and the Texas Cottonseed Crusher's Association to have it crushed without delay. A somewhat reassuring feature of the situation is that the great bulk of the seed imported was more than one year old and could not have carried any infestation. It will be necessary, however, to make very frequent inspections in Texas next season and to be prepared to stamp out any colonies which may have become established. In the meantime, if possible, a thorough exploration may be made in Mexico. Messrs. Hunter, T. C. Barber, Loftin, Dove, and Bishopp were engaged in work connected with this emergency during November. The outbreak in the Lagune District of Mexico is probably of two or three years' standing, but has probably only begun extensive spread in this district during the last year, and no instance of actual infestation has so far been discovered in the seed that has been brought into Texas. The occurrence of this insect in Mexico presents one of the gravest dangers which has ever confronted the cotton crop of this country, and unless the pink boll worm can be exterminated by coöperative work between the United States and Mexican authorities its ultimate infestation of the cotton fields of the Southern States is a practical certainty.

Insecticides Purer. That the Insecticide and Fungicide Act of 1910 has resulted in marked improvement in the quality of insecticides and fungicides entering interstate commerce is shown by the annual report of the Insecticide and Fungicide Board for the fiscal year ended June 30, 1916. Persistent sampling of four of the leading substances used in spraying shows a marked reduction in the number of violations of the act compared to preceding years. In 1915 only 8 per cent of the sam-

ples of lead arsenate taken were in violation of the act, whereas in 1911–12, 60 per cent violated the law. Similarly the violations found in lime-sulphur solutions had fallen from 94 per cent to 14 per cent, and Bordeaux mixture from 98 per cent to 36 per cent. Only 19 per cent of the shipments of Paris green examined showed any violation, whereas in 1911–12, 28 per cent of these shipments were objectionable.

While these results are probably due partly to the effect of deterrent prosecutions, they are due in even greater measure to the assistance the Department's scientists have accorded to manufacturers in making their products of standard strength and to the growing practice on the part of manufacturers of adapting themselves to improved methods and tests.

In this work during the past year, the inspectors collected 1,487 samples of different shipments. Of these, 190 were of insecticidal preparations for household use and 221 were of disinfectants, germicides, and bactericides for the prevention of diseases of human beings as well as of domestic animals. The Department during the past year has given particular attention to the prevention of the sale in interstate commerce of products recommended for household use which are either impotent or the value of which is misrepresented on labels. Many samples of arsenates, Bordeaux mixtures, sulphur, and other preparations also were taken.

In preventing the importation of misbranded or adulterated insecticides, the Insecticide and Fungicide Board collected 35 import samples. In the case of 5 preparations it was recommended that entry into this country be entirely forbidden or that the consignments be released only after being correctly labeled. In 9 other cases it was recommended that future shipments be detained. The remaining samples complied with the law.

The Board devotes considerable attention to investigational work for the determination of the value of various commercial insecticides and fungicides. It announces that it has under way tests of the merits of commercial dust and liquid sprays in the control of insects and diseases. These will include tests of articles composed of finely ground sulphur in combination with arsenate of lead, with a diluent such as finely ground lime or gypsum. The Board also is investigating the value of different commercial pyrethrum powders, tobacco powders, nicotine solutions, etc., when used as sprays, dusts or fumigants. Experiments have been made to determine the action of potassium cyanide and other substances in the control of insects and plant diseases when injected into the tissues of plants.

New Jersey Mosquito Meeting. The fourth annual meeting of the New Jersey Mosquito Extermination Association was held at the Hotel Traymore, Atlantic City, January 25 and 26. In point of general interest, attendance, and practical papers thoroughly covering the subject of mosquito control, this convention was perhaps the most successful ever held in the state or elsewhere. The following program was well carried out:—

"Present Status of the Mosquito Work."
By William Edgar Darnall, M. D., Atlantic City.

"The Circulation of Water on the Drained Salt Marshes—the need for and the way to obtain it."
By James E. Brooks, M. E., Glen Ridge.

"The General Principles of Salt Marsh Drainage."
By Harold I. Eaton, Atlantic City.

"The Maintenance of Salt Marsh Drainage Systems."
By William Delaney, Jersey City; John W. Dobbins, Newark; Fred A. Reilly, Atlantic City; Harry G. Van Note, Oakhurst; Stephen Johnson, Manahawkin.

"The Status of Mosquito Control Work." Symposium.

In Hudson County by Charles Lee Meyers, Jersey City.
In Bergen County by E. B. Walden, Hackensack. (Read by Mr. Howe.)
In Passaic County by Walter R. Hudson, Paterson.
In Essex County by Frederick W. Becker, M. D., Newark.
In Union County by Louis J. Richards, Elizabeth. (Read by Mr. R. W. Gies.)
In Middlesex County by Charles S. Cathcart, New Brunswick.
In Somerset County by E. F. Feickert, Plainfield.
In Mercer County by C. S. Suicerbeaux, Princeton.
In Monmouth County by William E. Warne, Keyport.
In Ocean County by Robert F. Engle, Beach Haven.
In Atlantic County by A. J. Rider, Hammonton.
In Cape May County by Joseph Camp, Pierces.

"The Essential Steps in Upland Mosquito Control."

"In Both City and Country."
By David Young, Paterson.
"In a Large City."
By Wilbur Walden, Newark.
"In the Village and Open Country."
By W. V. Becker, B. Sc., Newark.

"Salt Marsh Drainage Problems."
By C. C. Vermeule, C. E., East Orange.

"The Malaria Problem of the South."
By H. R. Carter, Assistant Surgeon General of the U. S. Public Health Service, Washington, D. C.

"The Essential Steps in Controlling the Typhoid Fly and Its Associates."
By L. O. Howard, Ph. D., M. D., Chief of the Bureau of Entomology, Washington, D. C.

"The Agricultural Utilization of the Salt Marsh."
By Jacob G. Lipman, Ph. D., Director of the New Jersey Agricultural Experiment Station, New Brunswick.

"The Place of Contract Work in Mosquito Control."
By Jesse B. Leslie, B. Sc., Hackensack.

"Publicity Methods."
By Russell W. Gies, M. Sc., Elizabeth.

"The Local Malaria Problem."
By Ulric Dahlgren, Ph. D., Princeton.

"Mosquito Control Work."

In Greater New York. By Eugene Winship, Department of Public Health of Greater New York.
In Nassau County. By C. C. Adams, Member of the Nassau County Mosquito Commission, New York City.
In Connecticut. By W. E. Britton, Ph.D., State Entomologist of Connecticut, New Haven, Conn.
In Virginia. By W. J. Schoene, State Entomologist of Virginia, Blacksburg, Va.

"The Meaning of Mosquito Extermination for the People of New Jersey—the past, the present, and the future."
By Ralph H. Hunt, M. D., East Orange.

Harry B. Shaw, who is in charge of the New York office of the Federal Horticultural Board, was absent on leave in Bermuda for two weeks during December. While in Bermuda Mr. Shaw devoted considerable time to the study of the plant pests of the island.

JOURNAL OF ECONOMIC ENTOMOLOGY
OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1917

The editors will thankfully receive news items and other matter likely to be of interest to subcribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will he acknowledged.—Eds.

Separates or reprints, if ordered when the manuscript is forwarded or the proof returned, will be supplied authors at the following rates:

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The New York meeting like its predecessor of a decade ago was a banner gathering. The program was a full and most interesting one. It is to be regretted that there was not more time, something characteristic of a really successful gathering and a matter which could hardly be bettered under the prevailing conditions. There were some conflicts between organizations having allied or overlapping fields and this must always be expected and allowances made. There is no system by which this can be avoided unless each of the special organizations can arrange to spread their meetings over a longer period. Then there would be trouble on that score.

It is evident that the special committee appreciated the various elements involved, since it brought in a report to the effect that the organization must have sufficient time for its members to present papers and for the transaction of business. This is equally true of all and adherence to such policy simply means some conflicts, possibly annoying at times, but under the conditions prevailing, unavoidable. It is presumable that adjustments will be made as heretofore and the difficulties of members desirous of attending the sessions of several organizations minimized so far as practicable.

An important step was taken when the publication of the Index to the Literature of American Economic Entomology, 1905–1915 was authorized. This work should be in the hands of some national agency and if the general government could not undertake it, as appeared to be the case, the Association was the logical medium to handle the work.

It is to be hoped that in embracing this opportunity, we may gain strength and enter a greater field of usefulness. Efficient tools are most assuredly worth while and if they are not at hand, it certainly is worth while to pause long enough to secure the necessary equipment, be it physical apparatus, requisite training or a comprehensive index.

"I never before addressed such a distinguished audience," was the sentiment expressed by one of our members in regard to the recent meetings. These words were from a well-known entomologist whom many delight to honor. It is true that these gatherings of entomologists are assemblages of fellow-workers, but who are they? Leaders of entomological work in its manifold applications in the various states, the nation and, to a certain extent, throughout the world are to be found, as nowhere else, in this relatively small group. Some are men of affairs accustomed to mold national and state policies in matters relating to insect control. They are all eager to learn the latest developments which may be of service in their work and most of them have only a limited amount of time which can be used in this way. These facts justify care in the preparation and delivery of papers so that there should be no ground for the following from a recent communication to the editor:

Why on earth people who have something to say which is worth hearing should not take the slight trouble to learn how to make it heard is one of the strange mysteries of modern life.

A. Conan Doyle.

"The amount of mumbling and indistinct talk at the New York meetings was extremely marked, and in my opinion rendered worthless many of the papers, and a great deal of the discussion. Anyone who has anything to say which is worth saying should take pains to speak distinctly if he desires to receive credit for it."

It is not contended that these faults are peculiar to entomologists. They are human traits. Economic entomologists are mostly public men; they should speak clearly, address the audience not charts or lantern projections and prepare the paper so that it will give a comprehensive idea of the subject within the time limits. We should take a professional pride in method of presentation and delivery as well as in investigation and administration.

D. J. Caffrey, Bureau of Entomology, reports the presence of *Toxoptera graminum* in the vicinity of Springer, N. M., and states that some of the aphids survived the recent cold snap when the temperature dropped to about zero, Fahrenheit. A recent examination showed that wingless aphids were present in the fields. A few parasitized specimens were collected during the first week in November from which adult specimens of *Aphidius testaceipes* were reared.

Current Notes

Conducted by the Associate Editor

Mr. E. L. Worsham, state entomologist of Georgia, visited Washington, D. C., for a conference on December 20.

According to *Science* Mr. C. B. Williams has been appointed to study the parasites of the sugar-cane froghopper in Trinidad.

Samuel Graham and S. Marcovitch have recently been appointed research assistants in entomology at the Minnesota Agricultural Experiment Station.

The California Academy of Sciences has a new museum building at Golden Gate Park, San Francisco, which was dedicated and formally opened on September 22, 1916.

Prof. Herbert Osborn, Ohio State University, was elected vice president, Section F., of the American Association for the Advancement of Science at the recent New York meeting.

Dr. E. G. Titus has resigned as professor of Zoölogy and Entomology at the Utah Agricultural College, Logan, Utah, to take charge of seed breeding work of the U. S. Department of Agriculture.

Mr. Alvah H. Peterson, formerly of the University of Illinois, has accepted a position as assistant in entomology at the New Jersey Agricultural Experiment Station, New Brunswick, N. J.

Mr. W. W. Henderson, formerly of Brigham Young College, Logan, Utah, has been appointed professer of Zoölogy and Entomology at the Utah Agricultural College, *vice* Dr. E. G. Titus, resigned.

Prof. T. D. A. Cockerell gave the Annual Public Address before the Entomological Society of America, at the American Museum of Natural History, New York, N. Y., Wednesday evening, December 27, 1916.

Prof. H. A. Morgan, dean of agriculture in the University of Tennessee, visited Tallulah, Mound, and other points in Louisiana in company with W. D. Hunter for the purpose of reporting on the field work of the Bureau of Entomology. Visits were also made to the laboratory at New Orleans and to the Experiment Station at Baton Rouge.

Prof. Charles T. Brues is listed to give one of the free public lectures arranged by the faculty of medicine of Harvard University. These lectures will be given at the Medical School, Longwood Avenue, Cambridge, on Sunday afternoons at four o'clock. Professor Brues will speak on April 1, and his subject is "Fleas and Other Insect Parasites in their Relation to Public Health."

The following appointments have been made in the Bureau of Entomology: A. P. Sturtevant, formerly of the Massachusetts Agricultural Experiment Station, to investigate bee diseases; Harry F. Dietz and Kearn B. Brown, entomological inspectors for the Federal Horticultural Board. Mr. Dietz has been assigned to Washington, D. C., and Mr. Brown to New York.

A conference on the pine blister rust was held at Washington, January 19, at the New Willard Hotel, in connection with the meeting of the American Forestry Association. The following entomologists were present:—S. A. Forbes, Urbana, Ill.; F. L. Washburn, St. Anthony Park, Minn.; J. G. Sanders, Harrisburg, Pa.; W. J. Schoene, Blacksburg, Va.; W. C. O'Kane, Durham, N. H.

According to *Science*, Mr. E. B. Williamson has been appointed curator of Odonata in the Museum of Zoölogy, University of Michigan. He will retain his residence at Bluffton, Ind., and will direct most of the work in his department from there, making frequent trips to Ann Arbor to inspect the collections. Mr. Williamson is at present on a collecting trip in the Santa Marta Mountains, Colombia.

The annual meeting of the Brooklyn Entomological Society was held on January 13 and the following officers were elected for 1917: President, W. T. Bather; Vice-president, W. T. Davis; Treasurer, C. E. Olsen; Recording Secretary, J. R. de la Torre Bueno; Corresponding Secretary, R. P. Dow; Librarian, A. C. Weeks; Publication Committee, J. R. de la Torre Bueno, C. Schaeffer, and R. P. Dow.

In the Bureau of Entomology, R. A. Cushman, North East, Pa.; E. B. Blakeslee, Springfield, W. Va.; H. G. Ingerson, Sandusky, Ohio; John B. Gill, Monticello, Fla.; R. J. Fiske, Roswell, N. M.; E. H. Siegler, H. K. Plank, Grand Junction, Colo.; H. B. Scammell, Tom's River, N. J.; F. L. Simanton, Benton Harbor, Mich.; D. E. Fink, Norfolk, Va., have returned to Washington to examine records and prepare manuscripts.

A conference was held in the Bureau of Entomology, Washington, D. C., December 20–21 for the purpose of discussing plans for a complete resurvey of the Hessian fly problem throughout the wheat-growing regions of the United States. The following entomologists were in attendance: Dr. L. O. Howard, Prof. S. A. Forbes, Dr. A. D. Hopkins, Dr. A. L. Quaintance, and Messrs. W. P. Flint, E. O. G. Kelly, G. G. Ainslee, W. R. McConnell, J. J. Davis, J. A. Hyslop, G. I. Reeves, and W. R. Walton.

The following entomological workers have resigned from the Bureau of Entomology: —W. H. Larrimer, formerly in charge of the field laboratory at Charleston, Mo., to accept a position in the Forest Service; R. N. Wilson, formerly in charge of the field laboratory at Gainesville, Fla., to accept a position as county agent, Palm Beach County, Fla.; H. K. Laramore, in charge of field station, Plymouth, Ind., F. M. Wadley, field assistant, Wichita, Kansas, E. S. Tucker, temporary field assistant, Baton Rouge, La., appointments terminated.

According to *Experiment Station Record*, Prof. J. A. Portchinsky, the distinguished Russian entomologist, died May 21, 1916, at the age of sixty-eight years. From 1874 to 1894, Professor Portchinsky was scientific secretary to the Russian Entomological Society, and since 1894 chief of the entomological bureau of the Ministry of Agriculture and chief editor of its memoirs. He was the author of twenty-four memoirs, besides a large number of other scientific contributions. He was also the Russian reviewer of the *Review of Applied Entomology*. He had traveled extensively over Russia, Caucasia, and Turkestan, and collected a mass of materials on the biology of insects.

The following changes and transfers have been made in the Bureau of Entomology: —A. F. Satterthwait, formerly of the West Lafayette (Ind.) laboratory, has been detailed to take charge of the Charleston (Mo.) Station; R. L. Nougaret, Walnut Creek, to Fresno, Cal.; W. M. Davidson to Sacramento, Cal.; A. H. McCray from apicultural investigations to work on insects affecting the health of man, stationed at New Orleans, La. The name of the Forest Tree Seed Insect Station, Ashland, Ore., has been changed to Pacific Slope Station, with J. M. Miller in charge; the station at Placerville, Cal., formerly called Pacific Slope Station, has been moved to Los Gatos, Cal., and will now be known as Forest Insect Laboratory, with H. E. Burke in charge.

The fifty-third annual meeting of the Ontario Entomological Society was held at the Ontario Agricultural College, Guelph, November 2 and 3, 1916. Dr. L. O. Howard, Washington, D. C., and Prof. P J. Parrott, Geneva, N. Y., were present from the United States, and Doctor Howard gave an evening lecture on "The Carriage of Diseases by Insects," which was illustrated with lantern slides. The following officers were elected for the coming year:—President Albert F. Winn, Westmont, Que.; Vice-President, Lawson Caesar, Guelph; Secretary-Treasurer, A. W. Baker, Guelph; Curator, W. Evans, Guelph; Librarian, C. J. S. Bethune, Guelph; Directors, Arthur Gibson, Ottawa; C. E. Grant, Orillia; A. Cosens, Toronto; F. J. A. Morris, Peterborough; J. W. Noble, Essex; W. A. Ross, Vineland Station; Delegate to the Royal Society of Canada, F. J. A. Morris, Peterborough.

Mr. Otto Heidemann, long connected with the Bureau of Entomology and custodian of the Hemiptera in the National Museum, died after an operation, on the morning of November 18 at the Homeopathic Hospital in Washington. Mr. Heidemann originally came to the Department in 1883 and for a number of years was employed as a wood engraver. With the development of photo-engraving his occupation was lost, and in 1893 he began for the first time the study of insects. It is an unusual thing for a man well beyond fifty to take up *de novo* the occupation which he is to follow ardently for the rest of his life. Mr. Heidemann became known all over the world as an authority on the group of insects which he studied. His address as retiring President of the Entomological Society of Washington on the eggs of Hemiptera was a paper of striking merit. He leaves a widow, Mrs. Mica Heidemann, well known as a sculptress and as a maker of insect models. [L. O. Howard.]

During the summer of 1916 a successful demonstration in anti-mosquito work was carried out in Minneapolis by the Minneapolis Real Estate Board. Ten square miles in South Minneapolis were chosen for the demonstration, an area typical of local conditions and of more than average difficulty. C. W. Howard of the Division of Economic Zoölogy of the University of Minnesota was placed in charge and six University students engaged for the work. The mosquitos mostly concerned were *Culex pipiens*, *Aëdes sylvestris*, *Aëdes canadensis*, *Culex restuans*, and *Culex tarsalis*, but especially the first two. In spite of the many large stretches of swamp and dumping areas, the mosquitos were reduced fully 99 per cent. So marked were the results that there has been a large demand for the continuation of the work next year under the same direction. The City Health Department will probably coöperate and the entire city will be covered. House-fly elimination will be included with the mosquito work. At least thirty-five men will be needed as inspectors. —University Farm, St. Paul, Minnesota, December 4, 1916.

At the recent annual meeting of the Entomological Society of America, held in New York, the following officers were elected:—President, Lawrence Bruner, Lincoln, Neb.; First Vice-President, E. M. Walker, Toronto, Ont.; Second Vice-President, H. C. Fall, Pasadena, Cal.; Secretary-Treasurer, J. M. Aldrich, West Lafayette, Ind.; Managing Editor of *Annals*, Herbert Osborn, Ohio State University, Columbus, Ohio; Executive Committee, the officers and E. B. Williamson, Bluffton, Ind.; A. D. Hopkins, Washington, D. C.; W. J. Holland, Pittsburgh, Pa.; E. D. Ball, Madison, Wis., and C. W. Johnson, Boston, Mass. The following were elected to the Editorial Board: T. D. A. Cockerell, Boulder, Colo.; William A. Riley, Ithaca, N. Y.; L. O. Howard, Washington, D. C.; P. P. Calvert, Philadelphia, Pa.; J. H. Emerton, Boston, Mass.; C. Gordon Hewitt, Ottawa, Ont.; Lawrence Bruner, Lincoln, Neb.; J. W. Folsom, Urbana, Ill.; and H. C. Fall, Pasadena, Cal. The Committee of the Thomas Say Foundation consists of the following: Nathan Banks, Cambridge, Mass.; A. D. McGillivray, Urbana, Ill.; Morgan Hebard, Philadelphia, Pa.; E. B. Williamson, Bluffton, Ind.; J. M. Aldrich, editor, West Lafayette, Ind.; E. D. Ball, treasurer, Capitol Bldg., Madison, Wis.

Mailed February 24, 1917.

CONTENTS—*Continued*

[1] Withdrawn for publication elsewhere.

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MANUSCRIPT for publication should be sent to the Editor, E. PORTER FELT, Nassau, Rens. Co., N. Y.

CURRENT NOTES AND NEWS should be sent to the Associate Editor, W. E. BRITTON, Agricultural Experiment Station, New Haven, Conn.

SUBSCRIPTIONS AND ADVERTISEMENTS may be sent to the Business Manager, A. F. BURGESS, Melrose Highlands, Mass.

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CONTENTS

JOURNAL
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Vol. 10 | APRIL, 1917 | No. 2

Proceedings of the Twenty-Ninth Annual Meeting of the American Association of Economic Entomologists

(Papers carried over or read by title)

THE GREEN-BUG (TOXOPTERA GRAMINUM ROND.) OUTBREAK OF 1916

By E. O. G. Kelly, *Wellington, Kans.*

Introduction[1]

The green bug (*Toxoptera graminum*) occurred in destructive numbers in Kansas and Oklahoma in the spring of 1916. This insect has been fully discussed in Bulletin No. 2, volume 9, of the University of Kansas, and in Bulletin 110 of the Bureau of Entomology, U. S. Department of Agriculture. The history of this insect preceding the 1907 outbreak is discussed in the above-named publications.

History, 1908–1916

The aphids were present on oats and wheat in early spring of 1908, in Oklahoma and Kansas, but were held in check by the activity of their principal parasite (*Aphidius testaceipes*) and rains. They were found in well established colonies as late as June, in Oklahoma, southern and northern Kansas, Nebraska, Iowa, Minnesota, North and South Dakota, and in July in central Montana, where they were very abun-

[1] Editor's Note: Owing to our limited financial resources, it was necessary to to ask Mr. Kelly to cut his paper in half. He has very kindly complied with our request.

dant on a salt grass. The country was generally infested in the fall of 1908, and they successfully lived through that winter in the grain fields in many sections, the worst infested wheat fields observed being those following oats in northern Texas and southern Oklahoma, where in early April of 1909 they had the appearance of a serious outbreak, but the favorable weather in late April and May gave the crop advantage and very little damage was done. A scattering few were observed in North Carolina and South Carolina.

In 1910 the species was very scarce west of the Mississippi river, but was observed in damaging numbers at several places in Illinois and Kentucky. In 1911 they were generally distributed through the eastern states. In eastern Oklahoma a limited incipient outbreak occurred; the heavy rains held it in check. They were reported from eastern and southern New Mexico. In 1912 few were observed anywhere, as was the case for 1913, except in South Carolina. In 1914 they appeared in large numbers in South Carolina, Georgia, and in scattering numbers over most of the eastern states, where they damaged oats and wheat. They were quite common from northern Texas to Nebraska. In 1915 they were common in South Carolina, Tennessee, Georgia, Texas, Oklahoma, Missouri, Arkansas, and Kansas. By November and December they had become so numerous in Kansas and Oklahoma in a few fields of wheat as to cause uneasiness among the farmers. In 1916 they occurred in damaging numbers in northern Oklahoma and southern Kansas and in a small area in northeastern New Mexico, also in scattering numbers to central Texas on the south and Nebraska on the north.

The Insect

Toxoptera graminum is an aphid of pea-green color, with a distinctly darker green stripe down its back, with black-tipped cornicles, and with a single forked cubital vein—these characters readily distinguish it from those most commonly found in wheat and oat fields, viz., *Macrosiphum granaria* and *Aphis avenæ.* It takes its nourishment by piercing the epidermis of the leaf with a beak adapted for drawing the juices therefrom; the effect upon the leaf is to cause it to take on a reddish-brown color, and, when heavily infested, to die.

In common with other aphids, its manner of reproduction is both sexual and asexual. In latitudes south of the 35th parallel, it appears that it only reproduces asexually, and north of this parallel both sexually and asexually. One thing very noticeable in the outbreak at Leavenworth was the entire absence of oviparous forms in the fall of 1907, and their presence in the fall of 1908.

The minor outbreak of 1909 in southern Oklahoma and northern Texas was not observed in the fall of 1908, nor was it followed in the

fall of 1909. However, during the fall and winter of 1909–1910 an experiment was conducted at Wellington, Kansas, laboratory, for the purpose of obtaining information on this point. In November a number of Toxoptera were placed on a breeding plat near the laboratory at Wellington for careful study of their resistance to freezes and to see what potent factors determined the sexual forms. On December 31 an examination was made, and it was observed that both adults and young were still alive on the wheat plants; though we had had several days of zero weather, no sexual forms occurred. January 27, 1910, many were still alive, and had survived some very severe weather, and there were still no sexual forms. On March 25, 1910, a few adults were found with no young accompanying them. These had evidently passed the winter, having found a protected place beneath some of the thicker growth of the plants. Special searches were made on this date, for oviparous forms and eggs, but none were found. On two occasions, one in December, 1909, and one in January, 1910, full-grown aphids and young which were frozen to bits of straw or ice, were brought into the laboratory, were allowed to gradually thaw out, and were later placed in breeding cages, where they grew, reproduced normally, acting as if they had not been in the cold weather at all; yet they produced no sexual forms.

In the fall of 1915 the insect was carefully studied in reference to sexual forms in the vicinity of Wellington, Kansas. Wherever the species was very abundant in wheat fields the plants, dry grass, and soil were examined carefully for eggs and a large number of the aphids were brought to the laboratory, where they were kept in breeding cages, both indoors and out, but at no time did the sexual forms appear. The question arises, then, what causes these forms to appear. Evidently it is not cold weather, because we had extremely cold weather during the winter of 1915–1916. We did not have such extreme cold weather during the fall of 1907 and winter of 1908. However, the notes indicate in the fall of 1908 that egg-laying forms were found on blue grass at Leavenworth and on wheat at Wellington.

Causes of Outbreaks

There have been four disastrous outbreaks of this insect, one in 1890, one in 1901, one in 1907, and the one in 1916. Aside from these, there have been a few minor outbreaks, but it appears from information gained from the weather records that the causes for the minor outbreaks in restricted localities have been similar to the causes of the larger outbreaks; at least, they are comparable to the seasons preceding the 1907 outbreak and the season preceding the 1916 outbreak, which were quite similar.

The season preceding the outbreak in 1890 was one which would have grown volunteer wheat and oats throughout the summer in the section of the country where the Toxoptera were abundant. Furthermore, it appears that the winter of 1889–1890 was of a mild type, especially in southern Ohio, southern Illinois, southern Missouri, and Texas. The spring of 1890 opened quite early and warm, but later changed to cold, raw weather, which continued up until the latter part of May. These conditions are readily comparable to the weather conditions of the spring of 1907 and the spring of 1916.

The outbreak of 1901 seemed to be confined mostly to northern Texas. By consulting the weather records, we find that in 1900, August, September, October, and November were very rainy months. This, of course, afforded an abundance of volunteer oats and wheat. March of 1901 opened up with showers and rains, which continued into April, with the weather turning cool with near frosts in April. The rains during the month of May were very light and a drouthy condition existed in north central Texas. It will be seen here that we have a condition very similar to that of 1889 and 1890.

Continuing our investigations, then, to 1906, we find that during the summer and fall the weather conditions were favorable for the growth of volunteer grain from central Texas to Nebraska, that is, rainfall was well distributed throughout July, August, and September. There are no records on file as to the amount of volunteer grain. However, our more recent investigations lead us to assume that there was plenty of volunteer grain where the rainfall was as abundant as in this season. The following winter was very mild. The spring of 1907 opened early and with slight rains in March and April, but here the weather man got his calendar mixed and we had it very cool in April and May, continuing cool up until late May. This insect, therefore, had the most favorable opportunities for increase.

In 1908, following the severe outbreak of 1907, a small area of wheat and oats in northern Kansas was damaged, this outbreak being evidently continued from the outbreak of the spring of 1907. Investigation indicated that the insect had been present in the infested fields since the spring of 1907, at which time the entire country to the south was being devastated, also that the devastated wheat fields had been planted to oats, and that occasional rains in July, August, and September had kept the oat plants suckering and green throughout the summer, and with the volunteer crop coming early in July, the aphids were permitted to feed and breed freely in the field, until wheat was sown. Shortly after the wheat was sown, the frosts killed down the oat plant, thus precipitating the Toxoptera on to the wheat; it, being young, of course succumbed readily. The devastation was not very

widespread, but indications in the fall of 1907 were that, in the spring of 1908, there might be a heavy infestation or general outbreak, should the spring be cold and backward as it was in 1907. The wheat fields were surrounded by blue grass in which Toxoptera were plentiful in November, 1907, and where they remained till the following spring. The fall was rather warm, the winter was not very severe, and it was not surprising to find as many as forty to fifty half-grown to adult aphids on a plant in early February and March, 1908.

The aphid showed up in abundance in the spring of 1909, in southwestern Oklahoma and northern Texas, where they did a lot of damage and threatened an outbreak, but here the parasites were present, and these, together with continued warm weather and considerable rain throughout April and May, held the pest in check.

Several wheat and oat fields in eastern Oklahoma were rather badly damaged in the spring of 1911 and in one or two fields, as much as twenty-five to fifty acres had been devastated. The oats were rather large at this time, and were heavily infested, many plants turning brown and dying. Owing to the downpour of rain on the night of April 8, the aphids seemed to be rather scarce, many of them being buried in the soil. A careful investigation all around this infested territory indicated that the insect must have been in that immediate locality since fall, 1910, as it would have been very difficult for them to have come from a distance, on account of the territory being more or less surrounded by timber, with wide sections of timbered land between this section and other cultivated sections. There was considerable blue grass growing near the fields, along the fence rows, which contained a number of aphids, and it is probable that the grass was more or less responsible for their passing the winter and getting an early start. May 5, these fields were practically free from the pest, and the plants were making a good growth. The heavy beating rains during April evidently cleaned the aphids off the plants. Inquiry among the farmers revealed the fact that there were considerable volunteer wheat and oats throughout the vicinity during the summer and fall of 1910. In one field where the volunteer oats were very plentiful all through the summer and fall, the Toxoptera gained such headway that they cleaned up the wheat, the field being seeded to oats early in the spring of 1911, and the oats being devastated. In this outbreak, then, there seems to be further indication that the volunteer oats and wheat were directly responsible for their presence in the fall, and continued presence in the spring. The rains in April and early May were responsible for their destruction, and from all indications the parasite *Aphidius testaceipes* was not a controlling feature, although present in large numbers.

During 1911, this species occurred everywhere in the midwest; however, the rains were general, and the species did not become abundant. The volunteer oats which were rather plentiful in August and early September died out later on account of the dry weather and cultivation, and by November it was very difficult to find Toxoptera at all.

The insect was not observed during 1912 in the vicinity of Wellington, nor practically any other place in the west. In May, 1913, a few were found on young wheat and quite a number on *Hordeum jubatum.* Wheat and oats were too far advanced, and with warm weather there was no danger from them. None could be found during the late summer and fall of this year.

1913 went on record as one of the hottest and driest years for the middle west, there being several weeks without rain. The rains came in plenty by mid-September, but none of this species were found on the wheat. Mr. W. E. Pennington made an excursion through northern Texas and southern Oklahoma, during the fall, and found a few individuals here and there on oats.

Early in April, 1914, reports of the insect came in from southern Oklahoma, investigation indicated that a few could be found on oats and wheat, and by mid-May they were generally distributed over Oklahoma and southern Kansas; however, the oats were large and wheat heading, so no damage was done. In December they were generally distributed over northern Texas, Oklahoma, and Kansas. The rains had been sufficient during August, September, and October, for growing of crops, but July was a record breaker for heat and drought.

In the spring of 1915 the aphids were plentiful throughout the west. This being an unusual year, with an abundance of moisture, especially in June, July, August, and September, the wheat and oat plants suckered freely, and were followed by an abundance of volunteer small grain, very early in the summer. The oats and wheat being fresh and juicy, naturally gave the insects food for rapid multiplication. In the fall it was not difficult to find good-sized colonies in every wheat field, and especially in fields following oats; by early December there were a number of wheat fields devastated in northern Oklahoma and southern Kansas. The frosts in October and November killed out the volunteer oats, thus precipitating the Toxoptera onto the small wheat, which they severely injured. The area of infestation seemed to be limited to about two counties, Grant county, Oklahoma, and Sumner county, Kansas. However, they were found almost everywhere in scattering numbers, throughout northern Texas, Oklahoma, Kansas, and even in northeastern New Mexico, where they were doing considerable damage to early fall-sown grain. Aphids were collected from points over the

west and kept in breeding cages for parasites, *Aphidius testaceipes*, which were reared from nearly every locality.

During the winter of 1915–1916 we had several freezes, the thermometer going as low as nine degrees below zero. Investigation during the winter indicated that the insect was living in the wheat stubble fields, along the protected fence rows, hedges, especially in rank wheat, and many of them crawled under clods. The weather warmed up rather early in March, 1916, with 80 to 90 degrees temperature during the last ten or fifteen days. The Toxoptera came from their hiding places and began to breed freely on the wheat. Our observations at that time showed that they were present in practically all of the thick growing wheat, the thin wheat not being infested. During March and April oats were planted in abundance, practically the largest acreage ever sown in southern Kansas and northern Oklahoma, because the wet fall of 1915 prevented seeding the land to wheat. By the middle of April, oats were sprouting and coming up from southern Oklahoma to central Kansas. The weather remained cool during this time, and Toxoptera continued to breed freely on the wheat. About the last week of April they began to migrate from the wheat to the oats, and by the first day of May it was not difficult to find the winged forms and small colonies on practically all of the oat plants throughout this territory.

Outbreak Imminent

The outbreak of 1916 began in the spring of 1915. As indicated by the above report, this insect is practically present at all times in some of our fields, more or less abundant, and ready to increase with the slightest favorable opportunity. In 1915 they were observed almost everywhere an entomologist who was interested in the species visited and looked for them. The cereal and forage crop entomologists of the Bureau of Entomology were observing them from South Carolina, across the continent through Tennessee, Missouri, and Texas, to New Mexico. The favorable conditions through June, July, August, September, and October of 1915, with its abundance of volunteer wheat and volunteer oats throughout all of the western states, extending from north central Texas to Nebraska, gave them the most excellent opportunities for establishing themselves. As fall approached, the farmers were asking if we were to have an outbreak of "green bug." Our one answer was, we cannot say, because we do not know what the spring will bring us, nor what the winter will do for the insect.

Investigation in December in northern Texas, by Mr. C. L. Scott, indicated they were rather plentiful northwest of Fort Worth, in the vicinity of Bowie and Ballinger, where there was an abundance of oats

and wheat, and they were also quite plentiful in the vicinity of Winters and Wichita Falls, and in the district around Sherman.

The species having been under close observation in the vicinity of Wellington throughout the season and since we had noticed their continual gradual increase up till October and November, 1915, we began to suspect that they were increasing more rapidly than usual. The first week of December they were so abundant as to be doing considerable damage to a number of wheat fields in Sumner county, Kansas, and in Grant county, Oklahoma, the heaviest infestation being in the vicinity of Medford. Upon noting the heavily infested fields near Medford, it was deemed advisable to make a thorough search of Grant county, Oklahoma, and Sumner county, Kansas, for the pest. Accordingly we drove some eight or nine hundred miles east, west, north, and south, in search of fields which might be as heavily infested as those around Medford and immediately west of Wellington, Kansas. No such infestation was located, but the insect was found in almost every wheat field visited, especially in wheat fields following oats. In almost every instance where we found as many as a dozen or more Toxoptera, we also found *Aphidius testaceipes*. The number of parasites present indicated that under favorable weather conditions in the spring we would not have an outbreak of this pest, if it was within the power of the parasite to control the pest, as had been claimed for it by one writer in discussing the outbreak of 1907, and the smaller outbreaks of 1908 at Leavenworth, Kansas, of 1909 in southwestern Oklahoma, and of 1911 in eastern Oklahoma. However, in the three latter cases, favorable rains assisted the parasites in the control of the pest, and I would not feel at liberty to give the parasites too much credit for what they did in controlling these three incipient outbreaks.

Outbreak Inevitable

On the 25th of April, after having investigated a number of fields in widely separated districts, it was apparent that we were to have an outbreak of this pest if the weather continued as it had been for the last thirty days. It seemed advisable that I inform the state officials that an outbreak was pending. I received a telegram from Mr. Dean, advising me that his able assistant, Mr. McColloch, would be in Wellington the morning of the 28th, and a long distance telephone message from Professor Hungerford, acting in charge in the absence of Dr. Hunter, stating that he would be in Wellington the morning of the 29th. Mr. McColloch arrived in Wellington at 7.15 a. m., April 28, and we started out on an automobile trip about 8 o'clock. We went west from Wellington on what is known as the Chisholm Trail, out by the way of Argonia to Harper, Kansas. We found Toxoptera quite abundant in

wheat fields on farms which I had visited several times recently. The wheat field on the Wilkerson farm, which was pastured in the fall, thus being freed of the pest, was also heavily infested at this date, and to the south an oat field was very heavily infested. We expressed an opinion that the Toxoptera were not abundant enough in the oats nor in the wheat to cause alarm. We visited the Treekman farm, where they were numerous in the fall, the wheat being practically devastated, except near the north edge, and Mr. McColloch found one parasite in a brown aphid. Living aphids collected from the Treekman field gave us a few parasites within the next ten days. Continuing the trip south from Harper, by way of Anthony, to Manchester, Oklahoma, we found Toxoptera much more abundant and began to change our opinion to one of some probability of serious damage, and accordingly Mr. McColloch wired the authorities at Manhattan that "the 'green bug' was generally distributed over all grain fields in Sumner and Harper counties, and if cool weather should prevail the next two weeks, the injury would be great, especially to oats, not only in southern Kansas, but probably over the greater part of the state." On the return trip from Manchester by the way of Bluff and eight miles south of Argonia, we found the "green bugs" much more numerous than we had along the Chisholm Trail. We did not find parasites elsewhere than on the Treekman farm, but the collections of Toxoptera from the vicinity of Manchester gave us parasites later.

On the morning of the 29th of April, Mr. Hungerford, together with Mr. Wellhouse, a student assistant of the University, arrived in Wellington. These men, together with Mr. McColloch and myself, drove east of Wellington toward Winfield, south to Arkansas City and on south to Kildare and Blackwell, Oklahoma, back by the way of Renfrow and South Haven. We found the species present in oat fields between Wellington and Oxford; in the oats and wheat to Winfield and to Arkansas City, but very scattering. One mile south of Arkansas City we found a forty-acre wheat field practically devastated, this being the heaviest infested field we had found in two days' drive. A careful search by these gentlemen and myself indicated that there were no parasites present. A number of aphids were collected and put in breeding cages, but no parasites issued. South of Arkansas City to Newkirk and Kildare we found a number of heavily infested oat and wheat fields. A number of the aphids were collected, but from these no parasites were reared. In the vicinity of Blackwell, Toxoptera were rather abundant. East of town there seemed to be no injury. They seemed to become more numerous as we went toward Blackwell from Kildare. Going west from Blackwell, we came to some of the fields which were heavily infested in the fall of 1915. These fields were being

damaged beyond doubt, many leaves being brown and heavily infested. The oats were two-leaved and 100 per cent infested. In the wheat fields where we found parasites plentiful in the fall, today we found some half dozen brown parasitized aphids. The individuals parasitized had crawled up to the tip of the topmost leaf of the plant, where they had changed to the brown form. This seems to be a characteristic of the parasitized aphid, and owing to the scarcity of them, it assisted us greatly in finding them. A large number of the living aphids were collected from wheat plants, and placed in a breeding cage; no parasites were reared from these, which indicates that the adult parasites had not been active in this field for some time in the past, probably not since last fall. About seven miles south of Hunnewell, Kansas, the fields were heavily infested, and here we found a few more of the parasitized aphids on the top leaves. Again we collected a large number of aphids and put them in breeding cages, from which no parasites were obtained.

Coöperation with State Officials

The apparent absence of the parasite from practically all of the fields in southern Kansas in April afforded an excellent opportunity for the study of parasite introduction. Representatives of the Kansas institutions came to Wellington on April 28, for the purpose of investigating the fields and to determine whether the parasites were present, and if they were absent, whether we could find a field to the southward where they were present in sufficient numbers that we could collect large numbers and later introduce them into the fields. Upon the arrival of the officials, we held a conference, wherein we decided that we would go together in the automobile of the department to the various fields in the vicinity of Wellington, and make a close search for the parasite.

Introduction of Parasites

On the 30th of April a slight misty rain fell all day. It was very cool and disagreeable, the wind being from the north. This was followed on May 1 by another cool day, with the wind in the northeast, threatening rain all day. However, in company with Messrs. Hungerford, Wellhouse, and Lawson, of the University of Kansas, T. H. Parks of Manhattan, who replaced McColloch, and E. L. Barrett, my associate, we began investigation of the fields in the vicinity of Wellington, for the purpose of determining whether the parasite, *Aphidius testaceipes*, was present. The oat and wheat fields on this day were generally and evenly infested, no spot more infested than another. Large numbers of the winged forms had flown into the fields and had started small colonies. Some of the offspring of the winged forms had reached maturity

and had begun to reproduce. We carefully looked for the parasites in the oat fields, and in the wheat fields to the north of town, spending the entire day making this search. We were unable to find parasites on the Toxoptera. We did find parasites on two other species of aphids, which were on weeds and grasses in the vicinity of the wheat fields. These parasites were subsequently reared and an attempt was made to introduce them into Toxoptera, but the attempt was futile.

Several oat and wheat fields were thoroughly investigated and determined not to contain the parasites (*Aphidius testaceipes*). We extended our investigation further to include the vicinity of Anson, where one individual parasite was found on the 25th day of April, by E. L. Barrett. Here we found four or five parasites in brown aphids. Then we went to the fields on the Treekman farm, where we found a few scattering individual brown aphids and the aphids literally destroying the wheat. On the Rarick farm, northwest of Mayfield, we found several parasites. However, since the parasites were not present in the fields northeast of Wellington, and especially those which we examined carefully, we decided that we would go to Medford, Oklahoma, where the parasites were abundant, secure a lot of them, bring them to these fields, and attempt an introduction. Accordingly, on the morning of May 4, we proceeded to Medford by automobile, for the purpose of securing the parasites. Driving on to South Haven and across to Caldwell, both wheat and oat fields were heavily infested and in danger of being destroyed. Just south of Caldwell we found wheat fields very heavily infested and beginning to show signs of dying. The change for the worse since the 27th of April was very evident. A careful search in these fields indicated that the parasites had not yet reached them. In some of the wheat fields the plants were eight to ten inches tall, but were dying, and dying fast. A large number of the aphids were collected in this vicinity and taken to Wellington, where no parasites were reared from them. We continued our investigations south and west of Caldwell to Renfrow, the fields being more and more seriously infested, and more seriously damaged, the farther we went. The oats were beginning to take on a red or brown appearance. Oats which were sown in a devastated wheat field just north of Renfrow were practically dead. A few parasites were found on oats and wheat in this field, more than we had found at any place south of the Treekman farm, and more than we had found anywhere, other than in the wheat field northwest of Medford. The situation in the vicinity of Medford was alarming; the oat fields were turning brown, as if a fire had swept over them. The wheat fields were just as badly infested as the oats, but the wheat, being larger, infestation did not show to be quite so severe. Many farmers were

harrowing or dragging the fields with brush drags in an effort to dislodge the bugs. Their efforts were in vain. In the field where the parasites were so abundant on previous visits, they were very abundant now, with an opportunity for our securing a lot of them. We collected several thousand of the brown aphids and several more thousand of the parasitized aphids which had not yet shown their parasitism. Many adult parasites were abroad, ovipositing. After making the collections of parasites, we drove south to Jefferson, where we found conditions quite the same as north of Medford. We returned to Wellington on a road leading directly north to Argonia. On this road we found some very heavily infested wheat fields which were practically devastated, and all of the oat fields south of the Kansas line heavily infested and in danger of being devastated; the parasites were in almost all of these wheat fields, and in some of the oat fields, but at no place were there so many as in the field one-half mile northwest of Medford.

On the morning of the 5th of May we proceeded to distribute about thirty thousand parasites and seventy-five to one hundred thousand aphids which had not yet shown parasitism, in each of three fields, two oat and one wheat field, which had been previously selected because of the absence of the parasites. We placed the parasitized Toxoptera in three points in each field, forming a triangle, the points being about one hundred yards apart. The living aphids, of course, began at once to crawl upon the plants for feeding purposes. The brown parasitized ones remained on the cut plants which we brought to the field. The increase in the aphids in the oat fields since our first visit on the 29th of April had been immense, far more than anyone could expect, fully 100 per cent of the plants being infested and some of them having from seventy-five to one hundred aphids to the plant. On April 29, we doubted there being a sufficient number of aphids on the oats to warrant an attempt at introduction of parasites. Representatives of the two Kansas institutions and myself were careful to make another examination of the plants for parasitized aphids immediately preceding the introduction, and we all expressed the opinion that there were no parasites present. Examination of the fields on the 6th of May indicated that the living introduced Toxoptera had crawled upon the plants and many of them were turning brown; some of the plants contained as many as six or eight of the brown aphids. We continued our investigation in other portions of the field, where the parasites were not introduced, but could not find a change in the situation, except the rapid increase of aphids and reddening of the plants. On May 8 the conditions in the three fields were very similar. Large numbers of the introduced aphids had crawled upon the plants and had turned brown;

on this date as many as thirty brown aphids could be found on a leaf, but brown aphids could be found only in the immediate vicinity of the small area where we had placed them. Again we searched thoroughly for parasitized aphids in other parts of the fields, and none were found. The Toxoptera were increasing in vast numbers and large numbers of winged forms were coming into the field. The plants were three and four leaved, as against one and two leaved on the 29th of April, with every leaf heavily infested and reddening. This being a warm day, the adult parasites were issuing from the brown aphids brought up from Medford, but not from those on the plants. Whether we had introduced enough parasites in any of these fields to overcome the heavy infestation seemed to be doubtful; they seemed to be gaining no headway, while the Toxoptera were gaining by great strides. Many of the oat fields were from 85 per cent to 100 per cent infested, the plants turning reddish-brown everywhere. Mr. Parks could not remain with me for the next day, so a drive of about one hundred miles to the north was made alone. I observed the Toxoptera to be very abundant in all the oat and wheat fields, to a line just south of Wichita, this line being the southern border of a rain which occurred on the 30th of April. North of Wichita to Newton very few Toxoptera could be found. Returning west of Wichita through Goddard I found the same conditions. Immediately south of the Santa Fé Railroad I began to find oat fields which were heavily infested.

On the 9th of May, it was decided that we had not made sufficient introduction of the parasites to be fully satisfactory, and upon the request of Dr. Hunter and Mr. Hungerford, we decided that we would return to Medford, secure more parasites, and try for further introduction. The fields were now becoming very heavily infested everywhere from Wichita south to El Reno, Oklahoma. Our observations en route from Wellington to Medford indicated that all of the wheat fields and all of the oat fields were heavily infested; oats having the appearance of having been swept by fire, much of it being totally destroyed, and wheat suffering severely. The conditions were more and more appalling as we neared Medford. We secured several soap boxes full of infested plants containing several hundred thousand of the parasites, from the field one-half mile northwest of Medford. These were brought to Wellington and released in the fields, where we had not put parasites on former dates. However, preceding the introduction, Messrs. Wellhouse, Lawson, Barrett, Scott, and I investigated the fields; we found a few parasites. About two hundred thousand parasites were liberated in each of two oat fields immediately west of town. The adult parasites were numerous in the boxes, issuing en route; these began ovipositing immediately upon being released.

On the 11th of May adult parasites continued to issue, from the introduced lots, but the cool weather retarded their activity and they had not distributed themselves very far from the points where we made the introductions. At a point one hundred and fifty yards east of the point of introduction in one of the fields, where introduction was first made, a number of parasitized aphids were found, and among them several winged forms, which indicated that some of these parasites had come in from abroad, and were not of those introduced. Again at five hundred yards east of the point where the introduction was made, bordering on the east side of the field, several parasitized Toxoptera were found, among them several winged forms; it is even more probable that these came in from abroad. The winged forms had been very numerous during the last few days, flying toward the north, and it would appear that these winged forms which had blown in from the south had lighted in these fields and had changed to the brown form, containing the parasite, and were not from the sources of introduction. This was further proven by the fact that the parasites which oviposited into the aphids on the morning of the 5th had not yet caused the aphids to turn brown, and further, by the fact that winged forms collected while in flight were changing to the brown form in the laboratory.

On the 18th of May there were not as many brown aphids to be found in the fields of first introduction as there were on the 11th of May, and in the fields where the second and larger introductions were made only a few adult parasites could be found, and it was difficult to find parasitized aphids away from the points of introduction. The cool weather between the 11th and the 18th had prevented them from multiplying or parasitizing any more aphids. The situation was growing worse daily with the weather continuing cool and dry. So far as could be determined, therefore, the introduction of the parasites was not a success, owing to the fact that practically as many parasites came into the field unaided by us as we introduced. The Toxoptera were devastating the oats and damaging the wheat very badly in spite of the parasites we had introduced.

An Important Excursion

Prof. G. A. Dean was regularly advised of the situation in southern Kansas by his assistants, J. W. McColloch and T. H. Parks. A telegram from Professor Dean stated that he, together with Professors Jardine and Call, would come to Wellington Monday morning, May 15, if the weather was suitable for auto travel. When they reached Wellington they informed me that it had been raining at Manhattan for several days, and that they had come through a heavy rainstorm all the way from Manhattan to about five miles south of Wichita. This

rain had been very heavy from Wichita north, extending northwest through the southern edge of Reno and on out to Stafford county, northward.

The weather being fine, these gentlemen accompanied me in my automobile on an inspection trip south of Wellington through Hunnewell, Kansas, to Nardin, Oklahoma, thence west to Medford, and directly north to Mayfield. We found the wheat fields heavily infested from Wellington to Medford, many of them being devastated, some of them being plowed up. The oat fields observed on this trip were condemned as worthless by all of these gentlemen. Many of the oat fields were being plowed up, and listed to sorghums, and many of them were so heavily infested as to be absolutely worthless. On this day we found a few of the adult parasites, or parasitized Toxoptera, in practically every wheat field we visited, and a few in oat fields. We continued our drive to the north on the morning of the 16th, going through Peck to Wichita, Newton, Mount Ridge, to McPherson, and on to Salina. We found the devastation extended to the southern border of the rain which occurred on the 13th of May, just south of Wichita. The heavy rain had beaten the aphids off the plants and caused the oats and wheat to outgrow the attack. A few individuals were found all the way from Newton north to Salina, but at no place were they in such numbers as to cause alarm. On the return from Salina I was alone, but went out by the way of Hutchinson. Southeast of this town many fields were heavily infested, but no devastation was yet apparent. Southwest of Wichita the situation was about the same, until I passed out of the rain belt.

Flight of Migrants

A few winged Toxoptera were caught on a large wire screen March 28; however, the general flight did not begin till the last of April or the first of May.

By the 18th to the 20th of May the oats and wheat were dying everywhere in southern Kansas and northern Oklahoma. Millions of the winged forms were flying and lighting on everything green, especially young corn. In northern Oklahoma many hundreds of acres of corn were devastated, and sorghums damaged by the winged forms. The first generation was about all that was produced on the corn and sorghum, the second generation seeming to be unable to survive. On May 22, billions of the bugs were flying all day long, and late in the afternoon it seemed that the air was absolutely full of them. They obstructed travel by getting in every one's eyes. Street lights were dimmed by them. The general direction of flight was always in the

direction the wind was blowing; a slight change of direction of wind changed their course as readily. Many of the winged forms carried larvæ of *Aphidius testaceipes*.

Disappearance after Devastation

The oats being dead and wheat heading, with the leaves drying up, there was very little left for the bugs to live upon; thus they destroyed themselves. During the last days of May and early June the weather warmed up and also continued dry. The bugs, having killed down their preferred food plant, were necessarily precipitated upon the soil. What would become of the hordes of wingless forms was a question of considerable importance. The winged forms had flown away to other fields, especially to the corn and kafir adjacent. Whether the hordes of wingless forms could reach the corn and kafir depended on their durability for long hikes; but fortunately they were too frail and readily succumbed on the heated surface of the soil.

The End of the Outbreak

During the last week of June and first two weeks of July, we made some long auto drives in southern Kansas and Oklahoma, observing the disappearance of the pest. A very few small fields of oats had been harvested, many had been planted to kafir and fetereta. The oat plants being dead, the bugs had necessarily died or left the field; wherever a green plant could be found, also a few aphids could be found. Wheat which had not been devastated was ripening; the bugs had about disappeared from them. By the middle of July it was difficult to find one anywhere, and those so fortunate as to find a green oat or wheat plant were being parasitized by *Aphelinus semiflavus* and not by *Aphidius testaceipes*. Together with *Toxoptera* went *Aphidius testaceipes* and the Coccinellids. The "green bugs" practically disappeared from this locality during the summer, and by late fall none had been found in Sumner county, though we had authentic reports of their appearance in McPherson and Cowley counties, Kansas. Thus the end of the most disastrous outbreak of "green bugs."

In Kansas the devastation reached an enormous acreage, about 250,000 acres of oats and 100,000 acres of wheat being devastated, this loss falling principally on four counties. The loss in Oklahoma was even greater than in Kansas, being as complete in destruction and covering a much larger area. The acreage of oats devastated has been estimated at 350,000, the wheat 160,000 acres, with 75,000 acres of wheat badly damaged, making a total of 600,000 acres of oats, 260,000 acres of wheat totally destroyed, and 75,000 acres of wheat badly damaged.

A COUNTY-WIDE SURVEY TO DETERMINE THE EFFECT OF TIME OF SEEDING AND PRESENCE OF VOLUNTEER WHEAT UPON THE EXTENT OF DAMAGE BY THE HESSIAN FLY

By T. H. Parks, *Extension Entomologist, Kansas State Agricultural College*

During the season of 1916 the Hessian fly (*Mayetiola destructor*) took a heavy toll from the wheat fields of central Kansas and pushed farther west into the state than had previously been recorded. The injury in the northern part of the state extended westward almost to the 100th meridian. The greatest injury occurred in the central part of the state, where this survey was conducted, and covered five counties in the heart of the hard wheat belt. The Hessian Fly Train,[1] operated in 1915 by the Atchison, Topeka and Santa Fé Railway Company in coöperation with the Kansas State Agricultural College, had made numerous stops in this section. The lectures given on this train, together with newspaper articles published at that time, served to set before the farmers a general understanding of the importance of applying the best known control measures in preparing the seed-bed and sowing the 1916 wheat crop.

The entomologists of the Kansas Experiment Station have always emphasized four things: (1) Thorough preparation of the seed-bed; (2) Destruction of volunteer wheat; (3) Sowing after the fly-free date, and (4) Coöperation among growers.

In the past, the farmers of Kansas have probably observed number three first, forgetting that along with this should go number one to insure a good vigorous plant in order to offset the disadvantage of a short growing season in the fall. Frequently this wheat fell before the attack of the spring brood of Hessian flies. Other growers who have paid more attention to securing a good seed-bed along with sowing late, have suffered loss because of the presence of volunteer wheat in the seed-bed. Coöperation comes last of all and is usually delayed because of lack of confidence, due to the failure to control the fly in individual cases by applying only one or more of the other three recommendations. Moreover, coöperation in all of these practices is often made difficult, due to the fact that Kansas farmers operate large acreages. To finish in the proper time seeding is frequently commenced early, and the earliest sown wheat becomes infested by the fall brood of flies.

McPherson county, central Kansas, was chosen as a county in which to conduct an extensive Hessian fly survey. This was in the nature of

[1]Dean, Geo. A., Jour. Econ. Ent., vol. 9, No. 1, 1916.

"follow up" work to learn the results of individual attempts to control the insect.

In 1916 there was early observed in this county a great difference in the degree of injury caused by the spring brood of the Hessian fly. The grain in some fields suffered but little while in other fields it was ruined by the fly. Frequently the most seriously injured grain had been sown after the fly-free date. This fact the farmers were always sure to remember and especially if, as occasionally happened, a neighboring field which was sowed before the fly-free date had escaped with less injury.

To explain these differences, as well as to secure some definite data on the value of an unorganized effort to control the Hessian fly, a questionnaire was prepared, and 306 fields in this county were visited and the owners consulted. Among the questions asked these growers were the following:

1. When was the field sowed?
2. Was volunteer wheat present in the seed-bed at seeding time? None, medium or much?
3. Did early sown wheat join?
4. What crops occupied the field in 1914 and 1915?
5. Was any stubble burned in 1915?

It was desired to determine the answers to the following questions pertaining to the control of the Hessian fly over an entire county:

1. What per cent of McPherson county wheat-growers believed in and had waited until the fly-free date for their county to sow wheat in 1915?
2. How much protection was afforded the 1916 crop by sowing after the fly-free date *without regard* to the amount of volunteer wheat present in the seed-bed?
3. What effect did the presence of *different amounts* of volunteer wheat at seeding time, in fields sown after the fly-free date, have upon the injury done by the spring brood of 1916?

These fields were visited usually in company with the farmer and the wheat carefully examined for injury by Hessian fly. Account was taken of the presence of lodged straws, dead tillers and number of flax seeds found present in representative samples taken in different parts of the field. The infestation was then classified as slight, medium or heavy, as the case might be, and so tabulated together with the other records given by the farmer. No data on the 1916 yields were obtained as this survey was conducted during July, and factors other than Hessian fly contributed to make the yields variable.

This work was made possible in the limited time available through the assistance of R. R. Reppert of the Department of Entomology,

Kansas State Experiment Station, to whom acknowledgments are here due.

The accompanying data, including the tables and graphic comparisons, were prepared to show the effect of time of sowing and the presence of volunteer wheat upon the degree of injury by the Hessian fly in this county in 1916.

A comparison of Tables I and II shows the effect of the time of sowing upon the control secured. The good of late sowing is here more clearly observed than the evil of early sowing. It is left for the reader to explain why 23 per cent of the fields sowed before the fly-free date escaped with slight injury, though these fields must have been heavily infested in the fall and probably were the source of a large part of the spring brood which damaged the wheat throughout the whole county. Table II shows the value of late sowing when the seed-bed is free from volunteer wheat. The five fields that were seriously injured were all near and usually adjoining early sowed fields. In one case a four-acre strip was sowed early and on both the north and south of this the adjoining fields of wheat, which were classed in Table II, were found to be very severely injured by fly. The north field was the more severely injured of the two, presumably because of the prevailing winds from the south during the spring. The early sown strip was too severely injured to harvest. The protection afforded the wheat in Table II shows the importance of even an unorganized attempt to control the Hessian fly by sowing after the fly-free date. In this class it was observed that the extent of the damage usually depended upon the ability of the plants to overcome the attack of the fly larvæ. Usually but a few were observed on each plant, and in good soil and on seed-bed well prepared, these straws were able to mature a head and remain standing even though one flaxseed was present near the base.

The effect of the presence of volunteer wheat in the seed-bed was even more noticeable than was expected. The grower's word was accepted for the amount of volunteer wheat present in his seed-bed. This could usually be verified by inspection. It was thought best to make but three divisions in regard to the amount of volunteer wheat present. A comparison of Tables II, III and IV shows the effect of varying amounts of volunteer wheat upon the subsequent injury by the spring brood of flies to the main crop of wheat sowed after the fly-free date. The heavily infested fields in Table IV were often in worse condition than those in Table I where no attention was given to time of sowing. Wheat shown in Table IV was probably subjected to equally as severe an attack by the spring brood of flies as that in Table I, but had the disadvantage of being younger and with fewer tillers. The figures in the last three tables show clearly that the degree of in-

jury by the spring brood depends directly upon the amount of volunteer wheat present at seeding time. Hence, the importance of destroying this.

Hessian Fly Control

Number of fields examined	306
Number in wheat 1915 and 1916	273
Number in wheat 1916, other crop 1915	33
Number sowed before the fly-free date in 1915	64
Per cent sowed before the fly-free date in 1915	20.9%
Number sowed after the fly-free date in 1915	242
Per cent sowed after the fly-free date in 1915	79.1%

Table I

Sowed before the fly-free date with or without volunteer wheat in seed-bed:

Infestation	Number Fields	Per cent of Fields
Slight	15	23.4
Medium	12	18.8
Heavy	37	57.8

Table II

Sowed after the fly-free date with no volunteer wheat in seed-bed:

Infestation	Number Fields	Per cent of Fields
Slight	78	73.6
Medium	23	21.7
Heavy	5	4.7

Table III

Sowed after the fly-free date with a medium amount of volunteer wheat in seed-bed:

Infestation	Number Fields	Per cent of Fields
Slight	46	44.2
Medium	40	38.5
Heavy	18	17.3

Table IV

Sowed after the fly-free date with much volunteer wheat in the seed-bed:

Infestation	Number Fields	Per cent of Fields
Slight	1	3.1
Medium	8	25.0
Heavv	23	71.9

No protection to the crop was noticed where the stubble had been burned over in 1915 and observations made in this county in 1916 give little encouragement from this source. The flaxseeds were too low on the stubble to be destroyed in large numbers. Less than 1 per cent of the acreage under survey had been burned in 1915 previous to plowing.

It seems that in Kansas, destroying volunteer wheat should take first rank in the war against the Hessian fly. After this is done there is little doubt of the good to be secured by late sowing. Either one done alone accomplishes little.

It was for the purpose of demonstrating these facts to the farmers of Central Kansas that this survey was conducted. Immediately after harvest in 1916 assembly meetings were held throughout McPherson county to give this information to the growers. Every effort was made to have county coöperation in Hessian fly control, and organizations by school districts were made to unite the farmers in an effort to control the Hessian fly in 1917. V. M. Emmert, County Agricultural Agent, coöperated in this organization work, and soon after harvest twenty-one assembly meetings were held throughout this county. Many of the men who attended these meetings had been visited by us during the survey, and had come to hear the results secured. These were presented to them as here given, and as these men had contributed toward the solution of this problem, a keen interest was felt by them. At many of these meetings definite organizations were made and as a result every effort was made to destroy the volunteer wheat in the seed-bed before sowing in 1916. In some localities less than 5 per cent of the 1917 crop was sowed before the fly-free date. At this writing some of the wheat sowed in the middle of September has been plowed under because of damage by the fall brood. To Extension workers these examples are an aid rather than a hinderance to the cause, for they stand as object lessons to the community. It is hoped that no organization will become so perfect that these self-invited demonstrations will be lacking.

STUDIES ON THE LIFE-HISTORY OF LIGYRUS GIBBOSUS DeG. (COLEOPTERA)[1]

By WM. P. HAYES, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

INTRODUCTION

Ligyrus gibbosus DeG. first came into prominence as an enemy of the wild sunflower. With our increasing knowledge of its habits, damage to new and important food plants is continually being charged to this

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 25. This paper embodies the results of some of the investigations undertaken by the author in the prosecution of project No. 100 of the Kansas Experiment Station.

beetle. The study of this species was taken up as a result of its growing importance as a pest of staple crops, and is being carried on as a part of the project on "Insects Injurious to the Roots of Staple Crop Plants" of the Kansas State Agricultural Experiment Station.[1]

Ligyrus gibbosus belongs to the coleopterous family Scarabæidæ, subfamily Dynastini. Fortunately, the references to this species have not been interspersed with synonymical confusion. Two described species, *L. morio* Lec. and *L. juvencus* Oliv., have been united with *gibbosus* by Horn (1875, p. 143).

The common names "carrot beetle," "muck beetle," "sunflower beetle," and "Ligyrus stalk beetle" have been proposed, none of which, because of their limitations, seem appropriate.[1]

History and Economic Importance

First mention of damage due to this insect is made by Comstock (1880, p. 274), who records adults as preying upon dahlias and the roots of sunflowers, both wild and cultivated. Webster (1889, pp. 382–383) records the beetle injuring carrots in Indiana, and Bruner (1891, p. 17) found them destructive to sugar beets in Nebraska. Weed (1895, pp. 156–157) reported the adults burrowing into and destroying stalks of corn in Mississippi, the damage being confined to limited areas, principally on corn land that had recently been in pasture. Howard (1898, p. 93) writes of injury to corn in Louisiana and carrots and dahlias in Wisconsin. The beetles are reported by Forbes and Hart (1900, p. 513) as abundant in Illinois and a brief account of the species is given. Chittenden (1902, pp. 32–37) describes the egg and adult and gives some notes from the United States Entomological Bureau on this species which he calls the "carrot beetle." The length of the egg stage was found to be ten days. Carrots are mentioned as the favorite food, while cotton and sweet and Irish potatoes are added to the list of host plants. Control methods are also suggested. This paper, although meager, is, by far, the best discussion of the species. Washburn (1902, pp. 47–49) reports damage to sweet corn and cites a futile attempt to use trap–lanterns in infested fields as a means of control. Essig (1915, pp. 245–246) states that adults have been reported feeding on the foliage of oak and elm and thinks that the grubs may be responsible for much damage to crops in California. A recent paper by Davis (1916, p. 264) states that "*Ligyrus gibbosus* and *L. relictus* have a one-year life cycle, the beetles pupating and appearing above ground in fall and reëntering the ground to pass the winter, not laying eggs

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[1] The writer wishes to acknowledge his indebtedness to Prof. Geo. A. Dean, Dr. P. S. Welch, and Mr. J. W. McColloch for kindly advice and assistance in preparing this paper.

till the following spring. The beetles are present at lights almost the season through, due to successive overlapping of broods. The grubs feed on manure and other decaying matter but the beetle of *L. gibbosus* feeds on the roots of various weeds such as *Amaranthus* and *Helianthus* and not infrequently noticeably damages crops of sunflowers. An interesting habit of the *Ligyrus* beetles is that they copulate under ground."

The foregoing references practically represent the present status of our knowledge of this species.

Related Species and Their Importance

By far the most important species of this genus is *L. rugiceps* Lec., known in the Southern States as the "sugar-cane beetle." Titus (1905, p. 7) states that in 1880 many farmers in the South were forced to give up the growing of cane because of this pest. Corn is also liable to injury. Another species, *L. tumulosus* Burm., has frequently been mentioned (Ballou, 1915, pp. 121–147, *et al.*) as a pest of maize and cane in the West Indies. *L. relictus* Say has been reported in the larval stage as injuring the roots of pyrethrum (Smith, 1902, p. 490). Two other North American species, *L. laevicollis* Bates and *L. ruginasus* Lec., have, so far as the writer is able to learn, not been cited as of economic importance.

Distribution

L. gibbosus, which is widely distributed over the United States, has been found from the Atlantic to the Pacific ocean. This wide range can be, in part, accounted for by the strong flight of the adults. In the collection of the Kansas State Agricultural College, this species is represented from the following Kansas localities: Manhattan, Winfield, Junction City, Onaga, Newton, Leavenworth, Scott City, Hays, Dodge City, Grainfield, and Eldorado. Mr. Warren Knaus, of McPherson, Kansas, has kindly furnished additional Kansas records from specimens in his collection, taken in the following counties: Seward, Meade, Wilson, Saline, Rooks, Lincoln, McPherson, Reno, Kiowa, Gray, Finney, Ford, Scott, Lane, and Wallace.

Food Plants

The following is a list of the known food plants of the adult of *L. gibbosus:* potatoes, sunflowers (wild and cultivated), dahlias, sugar-beets, ambrosia, oak, carrot, corn, cotton, parsnip, celery, and elm. The food plants of the larva are: pigweed, sunflower, wheat, corn, and oats.

In the records of the Department of Entomology, Kansas State Agricultural College, was found a note dated August 19, 1902, recording the adults feeding on the roots of celery. A large celery patch, under irrigation at Scott City, Kansas, was almost ruined by this species. As many as twenty-five specimens were taken around a single plant. According to another record, four individuals were found in celery stubs at Portalis, New Mexico, August 18, 1909. At Gove, Kansas, September 22, 1908, this species did much damage to sugar beets. It has also been found feeding at the roots of sunflowers at Manhattan, Kansas.

Description of Life-History Stages

The Egg.—The egg (Pl. 12, fig. 2) superficially resembles those of other related genera, such as *Cyclocephala*, *Phyllophaga*, *Anomala*, and *Euphoria*. It is almost globular in form, one axis being slightly longer. When freshly laid, it is about 1.5–1.8 mm. long and as development proceeds an enlargement occurs so that, when ready to hatch, it has increased to about 2.5 mm. It is pure white in color, smooth, and shining. As the embryo develops within, the color changes to a duller white and some of the lustre is lost. A few days after deposition, the young larva can be discerned through the shell. Just previous to hatching, larval segmentation, movement of the appendages, and the opening and closing of the brownish mandibles can be observed.

Eggs are laid at the bases of plants, preferably in soil, containing a large amount of decaying organic matter. In laboratory cages, they were laid in loose soil to the depth of 5–6 inches. Oviposition occurs as early as May 29 at Manhattan. In outdoor cages, the first eggs hatched on June 19. In hatching, the larva, doubled over within the egg, splits the shell in the region back of the head. By merely straightening out the body, the anterior half of the larva becomes free, while the shell remains attached to the dorsal surface of the abdomen. The larva, by bending the body and pushing with its head, finally works itself entirely free. These efforts are aided by twisting movements and rubbing against the surrounding soil.

The average duration of the egg stage of 555 eggs was 10.9 days, with a maximum of 22 days and a minimum of 7 days. Egg-laying began May 29 and lasted until July 24. Eggs were not laid by females taken at lights after the latter date.

The Larva.—The entire body of the newly hatched larva is white, except the brownish mandibles. A few hours after hatching, the head begins to darken and takes on its characteristic brown color. The body assumes a characteristic bluish color, and after feeding for some time a black meconium, due to dirt in the alimentary tract, appears in the posterior end of the abdomen.

The full-grown larva (Pl. 12, fig. 3) is about 31 mm. long and 9 mm. in maximum width. The head is brown in color and rather roughly reticulated. The whole body color is of a bluish tinge as are the grubs in the genus *Cyclocephala*. The spiracles are brown and somewhat prominent. The last abdominal segment bears ventrad a patch of short, straight hairs arranged triangularly. The double row of spines, found in this region in *Phyllophaga* and other genera, is absent. Dorsad, the last segment is devoid of hairs, but a few are present along the sides. The anal slit is transverse. Spines are present on the upper surface of the thorax and abdomen, but they do not seem to be as conspicuous as in *Phyllophaga*. As is the case with other grubs, three pairs of legs are found. The larva may crawl either on its side or on its feet and, when disturbed, lies coiled on its side.

In Kansas, the grubs have been found feeding on the roots of corn, oats, and wheat. They also thrive in soil that is rich in decaying organic matter, such as pasture land and freshly manured fields. In rearing cages, during the early part of the larval stage the grubs were successfully reared in soil mixed with manure. When about half grown, the larvæ were transferred to soil containing germinating wheat where they thrived on the roots, and frequently whole kernels of wheat were eaten before the seed had an opportunity to sprout.

In soil cages, freshly hatched larvæ were frequently seen eating each other. This habit probably accounts for a considerable amount of the exceedingly high mortality in rearing cages. During the past summer, out of 555 larvæ hatched from eggs, only 38 were successfully reared through to the pupal stage. The greatest death-rate occurred in pot cages containing fairly large numbers of grubs. The mortality is also high in cages where the larvæ are kept isolated.

The Prepupal Stage.—The grub, when full grown, sheds the meconial mass in the digestive tract and assumes a quiescent or prepupal stage. The body becomes smaller, being about 25 mm. long and 7 mm. wide across the thorax. The bluish tinge is lost and the grub becomes white in appearance except for the last three or four abdominal segments which remain darker and are much wrinkled, giving this end of the body a glistening appearance.

Previous to the transformation to the prepupal condition, the larva enlarges its burrow in the soil by packing the surrounding earth. Here it changes to the prepupa and later to the pupa. The coiled prepupa lies on its side and wriggles actively when disturbed.

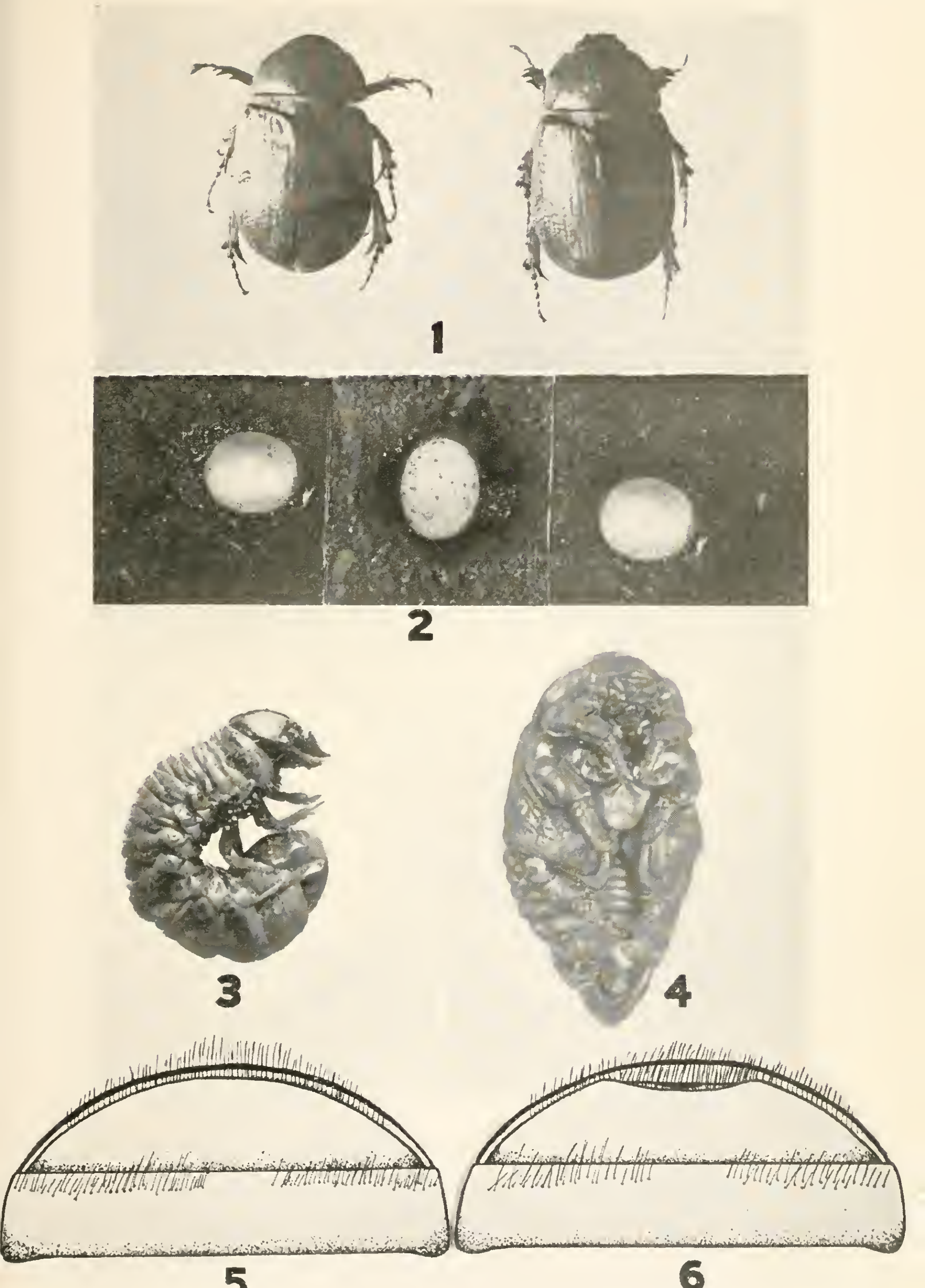
The combined length of the larval and prepupal stages was found to average 59.2 days for 36 specimens with a maximum of 80 days and a minimum of 43 days. The following table shows the exact length of each stage:

Development of Grubs from Hatching to Pupation

Record No.	Hatched	Became Prepupa	Length of Larval Stage (days)	Pupated	Length of Prepupal Stage (days)	Complete Time of Development (days)
565	June 23	Aug. 31	69	Sept. 6	6	75
390	June 26	Sept. 1	67	Sept. 7	6	73
472	June 28	Aug. 21	54	Aug. 25	4	58
533	June 28	Aug. 29	62	Sept. 4	6	68
896	July 1	Aug. 21	51	Aug. 25	4	55
1002	July 6	Aug. 23	48	Aug. 29	6	54
1083	July 6	Aug. 31	56	Sept. 6	6	62
1620	July 8	Aug. 31	54	Sept. 6	6	60
1637	July 8	Aug. 21	44	Aug. 27	6	50
1624	July 9	Aug. 23	45	Aug. 29	6	51
1640	July 9	Aug. 28	50	Sept. 3	6	56
1623	July 9	Sept. 5	58	Sept. 12	7	65
1962	July 12	Aug. 29	48	Sept. 5	7	55
1965	July 14	Aug. 21	38	Aug. 26	5	43
2037	July 14	Aug. 23	40	Aug. 29	6	46
2110	July 14	Aug. 25	42	Aug. 31	6	48
2095	July 14	Aug. 26	43	Sept. 1	6	49
2104	July 14	Aug. 28	45	Sept. 3	6	51
2048	July 14	Sept. 1	49	Sept. 8	7	56
1994	July 14	Sept. 1	49	Sept. 7	6	55
2073	July 14	Sept. 1	49	Sept. 8	7	56
2105	July 14	Sept. 2	50	Sept. 10	8	58
1979	July 14	Sept. 3	51	Sept. 12	9	60
2020	July 14	Sept. 20	68	Sept. 28	8	76
2035	July 14	Sept. 22	70	Oct. 2	10	80
3127	July 15	Sept. 17	64	Sept. 27	10	74
2752	July 21	Sept. 1	42	Sept. 9	8	50
2751	July 21	Sept. 5	46	Sept. 13	8	54
2797	July 24	Sept. 22	60	Oct. 2	10	70
2986	July 27	Sept. 5	40	Sept. 13	8	48
3004	July 27	Sept. 15	50	Sept. 24	9	59
3005	July 27	Sept. 22	57	Oct. 1	9	66
2985	July 27	Sept. 25	60	Oct. 4	9	69
2990	July 28	Sept. 13	47	Sept. 22	9	56
3052	July 28	Sept. 15	49	Sept. 24	9	58
3090	July 31	Sept. 27	58	Oct. 8	11	69
	Average	....	52.1		7.2	59.2

The average time for 36 individuals in the larval stage proper was 52.1 days, with a maximum of 70 days and a minimum of 40 days. The average prepupal stage for 36 individuals was 7.2 days, with a maximum of 11 days and a minimum of 4 days.

The Pupa.—The pupa (Pl. 12, fig. 4) is about 15 mm. long and 9 mm. in maximum width. Emergence from the old larval skin is accomplished by splitting the skin first along the epicranial suture and finally almost the full length of the back. In some cases, the pupa remains within the moulted exoskeleton, while in others it twists its way out. When newly transformed, the pupa is creamy white in color but soon darkens



Ligyrus gibbosus DeG.: (1) adults; (2) eggs; (3) larva; (4) pupa (ventral view); (5) last ventral segment of female; and (6) last ventral segment of male.

to a light brown, the abdominal segments remaining somewhat lighter than the rest of the body. As a rule, the pupa lies on its back. The only movement discernable is a slight twisting of the abdomen. Secondary sexual characters (to be described later) can be seen through the pupal skin and the sexes are thus easily determined in this stage. The average length of the pupal period was found to be 19.1 days, with a maximum of 29 days and a minimum of 11 days. The first pupa of the season was found on July 30, and the last near the end of October.

THE ADULT.—The adult (Pl. 12, fig. 1) is a large, cumbersome, brown beetle, often mistaken for one of the June-bugs or May-beetles, although the circular depression of the thorax with its small tubercle and the strongly punctured elytra easily distinguishes it from them. The size varies from 11 mm. to 16 mm., the males usually, though not always, being the smaller.

L. gibbosus may be described as follows: robust, convex, rather broadly oval, slightly wider posteriorly, reddish-brown to blackish, somewhat paler on ventral surface, moderately shining. Mandibles three-toothed on outer edge. Labial palpi inserted at sides of mentum. Antennæ lamellate, 10-jointed. Clypeus subtriangular, bidentate at distal edge, proximal margin with transverse carina. Clypeus and head with large confluent punctures. Eyes finely granulated, outer margin of head in front of eyes distinctly carinated. Thorax wider than long, sides regularly rounded from base to apex, margin slightly reflexed. A small tubercle at apex, followed caudad by a large circular depression. Surface finely punctate, punctures sparse and irregularly placed. Ventral surface of thorax and legs with long, dense, brown hairs. A small tubercle directly behind front coxæ. Anterior tibiæ tridentate. Middle and posterior tibiæ, each with two pubescent carina on outer edge, giving appearance of extra corbels. Punctures of elytra coarser than those of thorax, in nearly regular rows on disk, at sides irregular. Scutellum very sparsely punctured. Elytra subtruncate at tip. Pygidium exposed, triangular, finely and sparsely punctate. Ventral segments of abdomen smooth, shining, each with more or less distinct transverse row or setigerous punctures near outer margins. Distal margin of last ventral segment of male distinctly emarginate; of female, broadly rounded.

The sexes are distinguished by the characters of the last ventral abdominal segment. In the male, there is a distinct emargination at the distal end of this segment, while in the female its margin is obtusely rounded (Pl. 12, fig. 5–6).

When handled, the adults often excrete a white viscid fluid from the posterior end of the abdomen. They will extrude this liquid even when freshly transformed from the pupa. At this time the elytra are creamy white but change in a few hours to the characteristic brown color.

The beetles are attracted to lights at night. During the day, they burrow into the soil or hide beneath such objects on the ground as will give them shelter from the light. Mating occurs underground and in the darkness of these hiding places. During the past year, overwin-

tering adults were taken at lights as early as May 4, from which time on they were abundant until June 11. None were taken after this date until August 3. The lapse of time between these collections indicates a distinct separation of broods at Manhattan, although collections made throughout the summer at Junction City, Kansas, seem to indicate a distinct overlapping of broods at that place. The adults, which hibernate in the soil at depths ranging from six inches to four feet, emerge during the first warm nights of the following spring.

Summing up the life-history of *L. gibbosus*, adults are present in the soil throughout the winter and early spring. During the latter part of April, or the first few days of May, and continuing throughout the summer, they emerge at night and fly to lights, returning to the soil before daybreak. During the summer of 1916, eggs were plentiful at Manhattan from the last of May to late in July. Larvæ were present from June throughout the remainder of the summer and early fall, and pupæ from the last of July to the last of October.

Natural Enemies

The common toad (*Bufo americana*) is an important predaceous enemy of the adults, especially at night while they are flying at lights. Riley and Howard (1886, p. 189) cite the chuck-will's-widow as an enemy. Beal (1900, p. 70; 1911, p. 56) found adults in the stomachs of the crow blackbird and the flicker, while Judd (1902, p. 103; 1905, p. 41) found them in the warbler and mentions feeding the beetles to bobwhites.

During the past summer, three species of sarcophagid flies, *Sarcophaga helicis* Tns., *S. cimbicis* Tns., and *S. rudis* Ald. (MS.),[1] emerged from dead adults. The larvæ of the three parasites probably leave the dead adults when mature and pupate in the soil.

The grubs are attacked by what appears to be two distinct bacterial diseases, one of which produces pink and the other black lesions on the body. In rearing cages, fungi attack and kill many of the grubs.

Remedial Measures

No satisfactory method of control can be given for this species. Fall plowing, unless it be done early enough to break up the pupal cells, is practically useless, for the adults, when disturbed, can easily dig back into the loosened soil. The time of pupation extends over so long a period that no special time could be set to destroy the pupa by plowing.

Because of the preference of both the grubs and beetles for soil rich in decaying matter, it is evidently advisable, in regions where corn is damaged, not to plant corn in freshly broken pasture land.

[1] Determined by Dr. J. M. Aldrich, of the U. S. Bureau of Entomology.

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[1] Paper not seen by the writer.

ON THE LIFE-HISTORY AND SUCCESSFUL INTRODUCTION INTO THE UNITED STATES OF THE SICILIAN MEALY-BUG PARASITE[1]

By Harry Scott Smith

The Citrus Mealy-bug (*Pseudococcus citri* (Risso)) has been known to entomologists for many years as a troublesome greenhouse pest. It is only in comparatively recent times, however, that it has become an insect of economic importance in the orchard. In Florida it has been known as an out-door pest for some time. In California its first appearance as an enemy of orchards is obscure, although it was familiar on citrus in San Diego county as early as 1880. Since 1908 it has assumed a position of great importance in this state in the orange and lemon groves and much investigational work has been carried on in the attempt to control it. Up to the present time no great success has been achieved in this line, since it does not succumb readily to any of the methods of spraying and fumigation which are successfully used against other coccids found in citrus orchards.

There are a number of enemies of the Citrus Mealy-bug in California, some of which are of great importance at times. The most effective of these are the Brown Lacewings (*Sympherobius californicus* Banks and others). *Leucopis bella* Lœw is occasionally of importance, and *Cryptolœmus montrouzieri*, a ladybird which was introduced by Kœbele in the early nineties, at times renders great service close to the seacoast. There is only one internal parasite which is at all common, that is *Chrysoplatycerus splendens* (Howard), an Encyrtid which attacks the half-grown to full-grown mealy-bugs. It is of very little economic importance, however, since it breeds slowly and is local in its distribution.

During the summer of 1914 the California State Horticultural Commission maintained a laboratory at Palermo, Sicily, for the purpose of obtaining and introducing into this state any promising enemies of the Citrus Mealy-bug or of the Black Scale which might be found there. The collecting of mealy-bugs was undertaken by Mr. Henry L. Viereck and several shipments of these insects were forwarded to Sacramento. From one of these lots of mealy-bugs we were successful in rearing a few specimens of the odd little parasite which forms the subject of this paper. These were placed in a cage containing lemons infested with mealy-bugs and breeding took place with rapidity. Before many months we were enabled to place large colonies in the orchards of southern California.

[1] Occasional contributions from the California State Insectary No. 4.

Identity of the Species

This parasite was at first thought to be a species of the genus *Leptomastix,* a genus of which there have been recorded three species, one having the mealy-bug as its host. The insect was later studied by Mr. Girault, however, through the courtesy of Dr. Howard. He found it to represent a new species in the genus *Paraleptomastix,* which he had only a short time before described. He named the species *abnormis* and it was described in the *Entomologist* (London), vol. 48, pp. 184–185. It is one of the ectromine Encyrtids, in which group occur a number of important coccid parasites.

The Adult

The adult of *Paraleptomastix abnormis* Girault is very striking in appearance, due to its peculiar habit of holding its wings aloft when walking about, as is shown in the illustration. One wing is held in such a manner that it appears to be broken at the base. The peculiar banded wings are the most conspicuous part of the parasite's anatomy and will always serve to identify it among our California scale parasites. For a detailed description I transcribe herewith Mr. Girault's original characterization.

Female.—Length, 1.00 mm.

Differs from the description of the genotype in being like species of *Leptomastix* except that the postmarginal vein is elongate, a third longer than the lender stigmal, and over thrice the length of the marginal, the latter barely twice longer than wide.

Golden yellow—often dusky yellow—marked with dusky black as follows: Distal half to two-thirds of the abdomen, bulb of scape, cephalic aspect of the last two pairs of coxæ; funicles 1 and 2, club, proximal two-thirds of pedicel above, a conspicuous streak along the dorsal scape for its entire length, dorso-lateral edge; and frequently the entire disk of pronotum and scutum. Rest of antennæ pallid dusky, the scape, abdomen, pedicel, pro- and mesopleurum silvery. Propodeum blackish except laterad of the spiracle. Venation dusky. Apex of caudal wing and a longitudinal oblique streak opposite the submarginal vein, dusky. Fore wing conspicuously trifasciate, the first cross-stripe smallest, incomplete, obliqued caudo-proximad from before the bend of the submarginal vein; the second is complete, broader caudad, from the postmarginal vein; the third is largest, across just before the apex, not very broad, divided at middle narrowly and obscurely by a less dusky streak. Pedicel somewhat longer than wide at apex, somewhat shorter than funicle 1, which is two and a half times longer than wide; funicles 3 and following each being somewhat longer than 1. Club joints subequal to the pedicel. Head densely scaly punctate. Axillæ with a short carina between them. Scrobes distinct, not joined above. Dorsal thorax with a short silvery pubescence.

The male is about the same, but the third or distal stripe of the fore wing may be nearly absent, usually distinct. The scape is more compressed, the pedicel barely longer than wide, the club solid, the flagellar joints (excluding the pedicel) all somewhat longer and with scattered, rather long hairs, the funicle joints shorter than the club.

Habits of Adult

Paraleptomastix abnormis takes very kindly to domestication and is a very satisfactory parasite with which to work, since it is not affected adversely by confinement. It is industrious in habits and swarms about over infested fruit and plants in a businesslike manner, keeping constantly on the move in its search for a suitable host. It is not easily disturbed and will not fly unless forced to do so. In the orchards where it has become established one to a dozen may be found upon a leaf where they are continually seeking young mealy-bugs.

Oviposition

Oviposition takes place as soon as the adult has emerged and its wings have hardened, so that oögenesis must occur to a large extent before the adult parasite leaves its host. The younger stages of the Citrus Mealy-bug, first and second, are preferred as hosts. I have not observed oviposition in the last stage, although it would probably occur when this stage is forced upon the parasite. In the process of oviposition there is very little preliminary work, the female simply examining the host casually with her antennæ, then turning, inserting the ovipositor into the host's body, and depositing the eggs in a comparatively short period of time. The mealy-bug resents the attack by a considerable amount of squirming, but it is never sufficient to deter the parasite from carrying out her purpose. In nature she apparently places but one egg in a host, or at least one only reaches maturity, but when forced to do so she will deposit as many as 100 eggs in a single mealy-bug.

The Egg

The egg is of the usual oval shape with a minute projection at one end, very inconspicuous as compared with the stalk of many Encyrtid eggs. The egg proper is filled with granular matter which gradually becomes darker and more conspicuous as the embryo develops. There is no visible sculpture. The egg floats about freely in the body cavity of the host and hatching takes place in about five days. The ovarian egg is a quite different appearing object, as the accompanying illustration shows, there being a short neck or stalk with the egg proper at one end, and an enlargement at the other, nearly the size of the portion containing the embryo. This enlargement is transparent and is lost during or immediately after the process of oviposition. The function of this peculiar body is unknown to me, although it probably acts as a

Fig. 9. *Paraleptomastix*, ovarian egg. (Original.)

reservoir of the egg contents at the time of deposition. It is certainly not used as a breathing tube as is the case with many related parasites, since the egg is not attached to the host, but is free in the host's body cavity.

The Young Larva

The newly-hatched larva is without distinguishing characters, being transparent and with very indistinct segmentation, excepting that what might be termed the cephalic segments are set off from the others by a rather distinct suture, giving it somewhat the appearance of a young Ichneumonid larva. The mandibles are exceedingly minute and difficult to see, even with a high power compound microscope. The second stage is similar to the first excepting that the cephalic segments are more conspicuous, as are also the mandibles, and the caudal end is more attenuate, giving it still more the appearance of a young Ichneumonid. The skin of this stage is roughened, making it appear to be covered with minute tubercles. At the caudal end there is frequently a darkened area which may be the first stage moult skin.

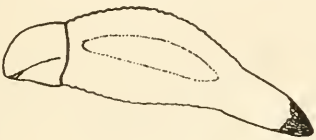

Fig. 10. *Paraleptomastix*, 2d stage larva. (Original.)

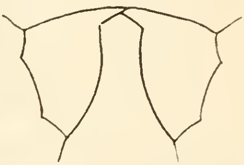

Fig. 11. *Paraleptomastix*, 2d stage, mandibles. (Original.)

The Mature Larva

The full-grown larva is of the usual Encyrtid type, with nothing characteristic excepting its mandibles. These are much larger and more conspicuous than in the second stage and slightly different in shape. It now rapidly devours the entire contents of its host's body which is killed in the process, the latter becoming much extended and cylindrical in shape so that it is easily distinguished from a healthy mealy-bug. The host now turns to an amber color and under the microscope the larva may be observed through the skin of the host. A condition is assumed very similar to a "mummified" aphid. These "mummies" are very characteristic and may be found in great clusters in the cage or orchard where the parasite is abundant.

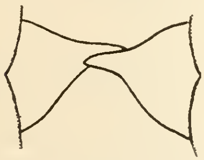

Fig. 12. *Paraleptomastix*, last stage, mandibles. (Original.)

The Pupa

The larva discharges its meconium into one end of the host's shell as soon as full-fed and moults for the last time. The pupa is transparent at first, but soon the eyes become pigmented and gradually the entire stage takes on a darker appearance. Emergence is effected by the cutting away of one end of the shell, after which the adult issues, dries itself and is ready for oviposition.

Fig. 13. *Paraleptomastix*, pupa. (Original.)

The entire life-history of this parasite requires from 25 to 45 days, depending upon the temperature.

Sexes and Parthenogenesis

The two sexes are about equally divided as to numbers, although the females are slightly in excess. While copulation takes place freely, this parasite, in common with most if not all Encyrtids, can reproduce parthenogenetically. In this case the progeny are males only.

Hosts

The principal host is the common mealy-bug *Pseudococcus citri* (Risso). While it occasionally will deposit eggs in the related species, *Pseudococcus bakeri*, I have never succeeded in rearing it on that host, the young parasites probably being destroyed by phagocytosis. Mr. O. H. Swezey of the Hawaiian Sugar Planters Station informs me that he has succeeded in getting it to breed upon the Sugar-cane Mealy-bug *Pseudococcus sacchari*, but it does not thrive greatly on that species.

Method of Rearing for Life-History Study

The most convenient way of rearing this and other parasites of *Pseudococcus citri* in the laboratory for life-history work has been found to be the use of infested green lemons. These are placed in a cage composed of a plaster of Paris base, into which is embedded a coil of wire which forms a support for the lemon. Over the lemon is placed a glass cylinder or chimney with a gauze or tissue paper top which permits of ventilation. A sufficient amount of moisture is usually supplied by the evaporation from the lemon. If the lemon tends to dry up, moisture may be added by placing the plaster base in a basin of water.

Rearing for Orchard Colonization

For orchard colonization it is of course desirable to rear these parasites in large numbers and this has been successfully accomplished by the use of both lemons and potato sprouts. For the latter method trays three inches deep and about sixteen inches square are filled with

a layer of potatoes and the interspaces filled with moistened sand. These trays are put in a warm dark place and sprouting occurs in a short time. Mealy-bugs are then introduced and breeding takes place very rapidly. These trays are made so that they will fit interchangeably in the breeding cages. In order to supply new host material in any breeding cage, it is only necessary to place the older tray on the lower shelf, with the fresh tray above. In this way all the parasites which may occur on the old tray as young larvæ or pupæ within the mealy-bugs are retained. This process of shifting the trays downward as each fresh tray is added, is continued until all parasites have reached maturity, when the older material is discarded. By this method we have been able to take thousands of adult parasites daily from the breeding cages for liberation in the orchards.

Handling and Shipment of Parasites for Colonization

The adults are collected from the cloth walls and top of the cage by use of a glass cylinder about two inches in diameter and eight inches long. This is provided with a cork at one end into which is inserted a short piece of 8 mm. glass tubing. This tube projects through the cork on the inside of the glass cylinder in such a way as to prevent the escape of the captured parasites. The cylinder itself is lightly filled with finely shredded paper upon which the parasites may rest. They are shipped or taken in person to the field colonies in these cylinders. When shipped by mail the cylinder is wrapped in moist sphagnum moss and this is then packed in a pasteboard box in its entirety. The method is very satisfactory for shipment within the state, but when sent to points outside the infested mealy-bugs themselves are forwarded, since the adult parasites do not survive a long hard journey. When colonizing the parasites in the orchard the cylinder is usually tied horizontally in a crotch of the tree and both corks removed. This prevents injury from storms. Where possible, not less than five to ten thousand are placed in a single colony.

Present Distribution

This parasite has been distributed pretty thoroughly throughout the mealy-bug infested sections of the state and has become established in practically every colony. The principal regions are the counties of Los Angeles, San Diego, Ventura, Santa Barbara, and Yuba, the latter in the northern part of the state, the former all south of the Tehachapi mountains. The species has also been sent to the Hawaiian Islands and to Florida.

Economic Importance of Paraleptomastix abnormis

There are at least two important general requirements which a parasite must fulfill if it is to become of value in the control of its host and

the measure of success it will achieve will depend largely upon how completely these requirements are fulfilled. In the first place it must fill a gap in the natural control of the host insect, that is to say it must not attack a stage of the host that is already subject to heavy attack by other parasites. In other words, it must form a new element in the biological complex surrounding the pest. The second requirement is that it must be able to adapt itself and thrive under its new environment, not only in relation to climate but in relation to artificial conditions which are brought about by man. At the present time *Paraleptomastix abnormis* seems to be all that could be desired in this direction. There is no parasite occurring in California which effectively destroys the first and second stages of the mealy-bug. These are eaten to a large extent by predaceous insects, but the parasitized individuals after they have reached a certain degree of development are refused by these predators. This has been observed frequently in the orchard, large numbers of the mummies being found in trees where the mealy-bugs are severely attacked by ladybirds and lace-wings. Its adaptation to environmental conditions is almost perfect. Coming from Sicily, it finds here a climate almost the exact duplicate of the one where it originated. By passing through two winters quite as severe as the average—if one may correctly speak of a California winter as severe—it has proven itself able to withstand our lowest temperature. At Marysville, adults were collected in large numbers a week after two freezes. It has also proven its ability to undergo successfully the hot dry summers of the interior valleys of this state. In our citrus orchards, many of which are infested by Black, Red and Purple Scale, it must be able to survive fumigation for those pests. In many of the orchards under observation it has successfully passed through two fumigations, probably as larvæ and pupæ within the young mealy-bugs. Spraying does not destroy it, excepting where it is successful in killing the mealy-bugs.

The question now arises as to what we may rightfully expect from the introduction of this parasite. It is now thriving and increasing rapidly in all the field colonies. The remarkable way in which it has increased during the short time since it has been introduced, the fact that it has proven itself adapted to environmental conditions, and the fact that it fills a gap in the natural control of the host, justifies, I believe, the hope that it will become of great economic value. It is too much, of course, to expect that this parasite alone will be able entirely to control the Citrus Mealy-bug, but its introduction will certainly prove an important step toward that desired end. Time alone will show its true worth to the citrus industry.

Adult of *Paraleptomastix* on the surface of a lemon. Greatly enlarged. (From Viereck, Mon. Bul., State Hort. Comm.)

Paraleptomastix abnormis, male and female. (Original photograph from life.)

Cages used in life-history work. (From Viereck, Mon. Bul., State Hort. Comm.)

Mealy-bug-infested potato sprouts, used in propagation of parasites. (From Branigan, Mon. Bul., State Hort. Comm.)

SOME PROBLEMS IN INSECT CONTROL ABOUT ABATTOIRS AND PACKING HOUSES[1]

By F. C. Bishopp, *U. S. Department of Agriculture, Bureau of Entomology*

Introductory

The attitude of the public in general toward the source and method of production of its food supplies had been largely a passive one. An increased interest along these lines is being exhibited and improved methods of handling foodstuffs are in evidence. Nowhere have rules of sanitation been more grossly abused than in the preparation and handling of foods of animal origin which constitute so large a part of the diet of the American people. The action of federal, state and municipal authorities has brought about during the last decade marked improvement of sanitary conditions under which meat food products are produced. While these activities have not always involved campaigns against flies they have always resulted in affecting fly control in some degree. Possibly the greatest advance along the line of improving the quality and cleanliness of this group of products has been made by the operation of the federal meat inspection act as carried out by the United States Bureau of Animal Industry.

The question of producing animal products in a sanitary way has many sides, and the meat inspection service has been ever awake to the possibilities of improving in various and sundry ways the efficiency of their service. The question of fly control has received no little attention from them, but many problems of a special nature arose which resulted in the request that the Bureau of Entomology coöperate with them in the study of the relation of insects to the packing industry.

Mr. George H. Shaw, Sanitary Engineer of the Bureau of Animal Industry, working under the general direction of Dr. R. P. Steddom, chief of the meat inspection division, had given the question of fly repression some attention before the Bureau of Entomology took up the work, and these gentlemen, as well as inspectors in charge of federal meat inspection in different parts of the country, have shown hearty coöperation in the conduct of the investigation which has been carried on for the greater part of two seasons by Mr. E. W. Laake and the writer.

One of the encouraging features of the work is the general acceptance as an unquestioned fact that flies and other food-infesting insects are a menace to public health and should be controlled. This speaks highly of the educational propaganda along this line which Dr. L. O. Howard has been foremost in promoting. Nearly all of the fed-

[1] Published by permission of the chief of the Bureau of Entomology.

eral inspectors and many of the officers of the packing establishments have shown interest in the question of insect control about the respective establishments. In many cases the packers are inclined to delay putting into force measures recommended and attempt to justify their attitude with the statement that little can be done toward control as long as municipalities immediately surrounding them do nothing along this line. In many other instances, however, the superintendents of meat packing plants have coöperated heartily in all control work undertaken. The work, in so far as it appertains to establishments under federal control, is progressing very satisfactorily. It might be mentioned that this is one of a few instances where recommendations looking toward the control of insects can be successfully put into effect by law, but here, as in most other cases, educational work can be largely depended upon to bring results.

Some of the Special Ppoblems Involved

In general, it is found that the packing houses under bad fly conditions produce the major part of the flies and other insects which give annoyance about the respective premises. On the other hand, when these plants eliminate practically all breeding places, flies still exist in considerable numbers and it must be conceded that large numbers come from surrounding breeding grounds not under the control of the establishments. Unfortunately, many packing houses are located in districts where the conditions are favorable to insects and in turn the establishments themselves tend to produce this class of conditions in their environs. In some cases portions of cities abutting the packing house and stock yards districts are inadequately provided with sewers and many other insanitary conditions prevail. It has also been observed that city dumping grounds, where all sorts of refuse is accumulated and flies are bred in myriads, often are not far removed from slaughter house districts. The houses themselves, on account of the production of various types of attractive odors, seem to have a tendency to center the flies from all of these outlying districts in their immediate environs. Hence the proprietors and operators are confronted

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Explanation of Plate 15

1. Dump at slaughter house showing method of filling low places with paunch manure and other refuse. Note the roughened appearance of pile at left due to burning of dry portions, and smoke from fire at right. Unfortunately burning of fresh material which will produce flies in great numbers is difficult under out-door conditions.

2. Small rendering plant where fly conditions are very bad. Note offal on platform with open bin containing bones behind it. The meat is largely disposed of by maggots. Photographs by H. P. Wood. (Original.)

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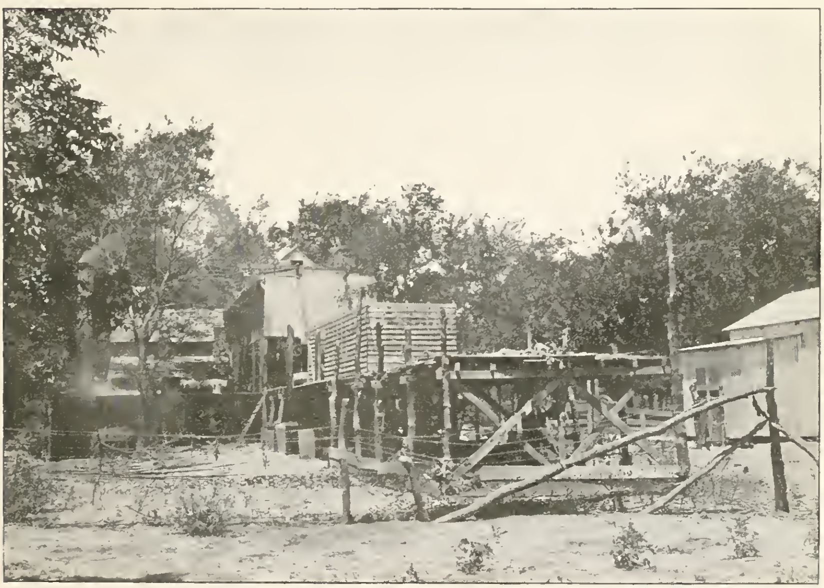

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with a problem not only of preventing the breeding of flies on their own premises, but of destroying those which are so freely contributed by surrounding breeding places. In addition to those insanitary conditions mentioned, it is not infrequent to find rendering plants, both for garbage and dead animals, glue works, fertilizer factories and city sewer discharges located in the same districts. Fortunately, engineers have devised means of greatly reducing the amount of odor given off by the various manufacturing processes involved, and still further development along this line in under way. This should render not only the establishments less attractive to flies, but should also aid in improving city conditions in the vicinity of such plants.

Another condition, which is somewhat different from that encountered in most fly control work, is the accumulation of large amounts of material of vastly different kinds which, when not receiving proper attention, produces abundant breeding places for many species of insects. For example, it was formerly not uncommon to find on some packing house premises, enormous piles of manure from cattle paunch —in some cases several hundred feet long—tons of undried blood and meat tankage often infested with maggots when shipped in from smaller plants, carloads of bones of various kinds which furnished admirable breeding conditions for a number of species of blow-flies, thousands of sheep pelts which in some cases were air-dried and bred flies during the process, warehouses full of hoofs, horns and various classes of dried bones which produced swarms of hide and ham beetles as well as skipper-flies. In the immediate environs of slaughter plants it was formerly the practice to dry hog hair on the ground. In some instances acres of hair fields were found, and during the drying these bred numbers of flies beyond comprehension. Sometimes great areas exist in the vicinity which are covered with manure removed from stock yards and in cleaning cars. Numerous temporary breeding places are produced by the breaking or clogging of pipes or boiling over of stickwater vats which may render many square yards of earth suitable for breeding myriads of flies. In some of the large plants the fertilizer industry is carried on in large proportions. The receipt of many cars of dried bones at such establishments is not uncommon, and we have found these to be fertile breeding places for the so-called skipper-fly. Many other conditions favorable for fly attraction and breeding might be cited.

There are some advantages in the usual grouping together of a number of packing establishments in one district, for in these cases the operators usually have complete control of such districts and if they assume the proper attitude much beneficial work can be done through them. While the meat inspection service does not exercise direct

control over the stock yards, in a number of important centers the establishment proprietors own a controlling interest in these yards and hence much improvement can be brought about if their attention is directed to the existence of insanitary conditions in such yards. This applies more especially to the larger establishments, nearly all of which are under government inspection.

In those plants which are under proper supervision an opportunity is afforded for systematic efforts toward the immediate alleviation and ultimate elimination of these conditions. A somewhat different and much more serious set of conditions prevail at the small slaughter houses not under inspection. In nearly all these no facilities are provided for the utilization of any of the offal or manufacture of any by-products which results in the production of exceedingly insanitary conditions instead of giving clean premises and a substantial financial return. In some instances hogs are yarded around the uninspected slaughter houses where they feed upon the blood and offal, and thus are subjected to dangers of infection with tuberculosis and other diseases, as well as internal parasites, to say nothing of the indescribable fly-breeding conditions produced. The wallows made interfere with drainage and the blood and remaining portions of entrails, bones, etc., accumulate in the surface mud and sometimes render the entire pen a prolific fly-breeding ground. In other instances the maggots and bacteria are depended upon to dispose of the entrails and clean the bones. Usually the flies emerging from their filthy environment have ready access to the slaughter house, the interior of which is usually in keeping with the outdoor conditions. Little or no effort is usually made to prevent flies in countless numbers from swarming over the freshly skinned animals, but some precautions, such as killing late in the evening or the generation of smudges, are necessary to prevent the blowing of the meat, which, nevertheless, frequently occurs. These crude steps are taken not for sanitary reasons so much as to avoid loss from trimming or the danger of the meat exhibiting to the prospective buyer some gross evidence of the very obnoxious conditions under which it was prepared.

Species of Insects Concerned

The insects which cause trouble about packing houses may be divided into three groups: The Diptera—including house-flies, blow-flies and others; the cockroaches, and ham and hide beetles. From the point of view of the packer and the sanitarian, the house-fly and various species of blow-flies are of by far the greatest importance. The season of the activity of blow-flies is somewhat greater than that of the house-fly on account of the varied seasonal habits of the different

species concerned. In general, it may be said that the blow-flies give greatest annoyance about the inedible departments of the establishments and where fresh blood is present. While the house-flies also exist under these conditions they are found in greatest numbers about the portions of the plants where the finished products are to be found. They are especially numerous about the various loading docks and in sausage rooms. House-flies may also give annoyance in certain departments where scarcely a blow-fly is to be seen. They are also very troublesome in the wholesale markets connected with the packing establishments. Although the kind and number of blow-flies vary somewhat in different regions, it may be said, in a general way, that the common black blow-fly, *Phormia regina*, is the most troublesome of this group. In the middle of the season it is often supplemented or replaced by the green-flies, *Lucilia cæsar* and *L. sericata*, and occurring with it is the large bluebottle-fly, *Cynomyia cadaverina*, and several species of Calliphora, notably *erythrocephala*, *vomitoria*, *coloradensis*, and *iridescens.* In the South the screw-worm-fly, *Chrysomyia macellaria*, often becomes excessively abundant during the summer season, while the other species mentioned are greatly reduced in numbers or entirely disappear. Several species of Sarcophagids are also in evidence during the summer months, but they are usually not present in great numbers and seem less prone to enter buildings. The black anthomyid flies, *Ophyra aenescens* and *O. leucostoma*, are sometimes present in considerable numbers, but are to be found only rarely within buildings. The former of these is found only in the Southern States. *Fannia canicularis* and *scalaris* are common, but are not given to free visits to animal products. The skipper-fly, *Piophila casei*, is usually present during the summer months about nearly every establishment, but on account of the care exercised in protecting cured meats it is seldom of any particular importance except in branch houses where it often causes considerable loss.

The three species of cockroaches commonly found in the United States are present in greater or less numbers about packing houses. Their abundance and the consequent danger of contamination of food products by them is greatly lessened by the construction of buildings of steel, concrete and brick. In some of the older plants they are a source of much annoyance.

The ham and hide beetles, like the skipper-fly, seldom do any material damage to products about the establishments, due to care exercised in handling material subject to their attack. They have been reported as doing considerable damage to products in branch houses and about small establishments not under government supervision.

Lines Followed in Control

It has been the practice of packing concerns heretofore to spend all the funds used improving the appearance of their premises on the front of the grounds. This plan is being changed considerably and much attention is given to the cleaning and beautifying of the interior portions of the grounds.

On account of the conditions mentioned in the preceding pages it has been found necessary to practice nearly all known means of fly control. The first consideration is to abolish breeding places. This demands many permanent improvements. It has been found best, from the standpoint of the operator as well as from the sanitarian's point of view, to permanently abolish in so far as possible all breeding places rather than to depend on giving them constant attention. As illustrations of the permanent improvements desirable may be given the construction of good buildings for all manufacturing processes, especially where tanking and other work which is conducive to the attraction and breeding of flies is done. This permits of thorough cleaning in these inedible departments as well as in the portions of the plant where products intended for food are handled. The installation of modern equipment with ample capacity for use in such processes as tankage drying, hair drying and bone drying, and also a provision for ample storage room. The concreting of horse stalls and holding pens for stock and areas where paunch manure, stable manure and hog hair are loaded are usually necessary to attain the ends desired. The prompt shipment of manure and undried hog hair, green bones and hides should be insisted upon when this method of disposal is followed. When hog hair, horns, hoofs and bones are dried at the plant this must be done promptly and thoroughly. The proper tanking of bones has also been found to decrease the amount of fly breeding in this class of material, especially if the bone tankage is stored under roof.

Probably the most important single improvement which can be installed is an incinerator with a capacity sufficient to handle all refuse, such as paunch manure, stable manure, settlings from catch basins, and damaged crates and other containers, soiled wrappers and sawdust, all of which are attractive to flies. The question of the installation of incinerators is one which deserves consideration by every municipality, as well as the packing houses.

When all possible breeding places have been eliminated there still exist some places—usually of a temporary nature—which must be treated for the destruction of maggots and the prevention of egg-laying by the flies. It has been found that often a very small leak in a blood conveyor or stick water tank will produce favorable breeding places

in the soil adjacent for great numbers of flies, and accidents leading to the infestation of the ground or in case of accumulation of temporary breeding materials it is necessary to use some larvicide. Crude petroleum has been found very helpful in preventing breeding in these temporary situations. Where the amount of the breeding material is large, however, the oil does not succeed in killing all of the maggots unless applied very freely and frequently. The application of crude petroleum to the grounds of the packing houses also aids in keeping down dust, which is an additional good feature. Where incineration is not practiced, the use of borax on paunch manure and other breeding media has been found satisfactory. It is also effective in treating temporary breeding places of various types. It has been used at about the same rate as that recommended for the treatment of stable manure. The prompt covering of breeding materials on dumps with fuller's earth, which has been discarded after use in lard refining, has been found to check fly breeding materially, but should be employed only as a supplemental or temporary measure.

On account of the attractiveness to flies of abattoirs and packing establishments we hold that fly traps fill a very distinct place in control work under such conditions. While the Hodge type window trap has been found of some value under certain conditions, in general it seems best to attempt to attract the flies into traps on the outside of the building rather than to catch them in the windows or within the departments. The kind of bait used has to be modified to suit the conditions and the species of flies present. The mucous membranes from hog intestines (a by-product of sausage casing manufacture) has been found to be by far the most attractive bait for blow-flies, and also catches a large percentage of house-flies. On account of its odor this material cannot be used around edible departments and in front of the establishments. As has been explained, the house-fly predominates in such situations and therefore stale beer or some other good house-fly bait is satisfactory in these situations. The simple conical trap as described by the Department has been found most effective and durable.

In wholesale markets and departments where edible products are manufactured, it is important that practically all flies be excluded. For this purpose, window screening is largely employed, but under conditions which often exist these are not sufficient as the flies gain entrance through doors which are being opened very frequently. Blowing devices have been employed in such passage-ways with some success, and Hodge traps or fly exits through the window screens are helpful in keeping the number of flies on the inside to a minimum. Other difficulties in fly exclusion are met with in keeping flies from

entering through the chutes with the live stock. Some inspectors have found it possible to exclude most flies by providing a considerable darkened space before the cattle enter the knocking pens.

The question of reducing odors, which has been touched upon, is an important one. It had been found that flies are attracted considerable distances on account of the odor produced by packing establishments, and it is believed that the number of flies attracted is largely in proportion to the volume of this odor.

The methods of handling finished edible products often have to be modified considerably to avoid contamination from flies. The prompt passage of the carcasses into the coolers is an important step, and the covering of various products also helps to maintain a higher degree of cleanliness. Thus much fresh meat is provided with light coverings, hams and sausages are wrapped with care and attention is given to the protection from fly contamination of meats when on wagons.

It is not infrequent that shipments of hams and bacon held for some time in branch houses become infested with skipper-flies and these are returned to the producing house. On account of the fear of introducing this pest into the storage rooms, the packers usually destroy such meats immediately regardless of the extent of infestation. This causes a considerable loss which might be avoided. The loss from ham beetles is of similar nature. The proper wrapping of these materials reduces the chances of infestation and it is important that they be stored in clean, dry rooms carefully screened with fine mesh wire.

Cockroach control depends to a considerable extent upon the conditions of the buildings. The number of roaches is always greatly reduced in modern structures free from wood, and under such conditions there is seldom any trouble owing to the common practice of freely using hot water and steam in cleaning up all departments. Storage rooms are sometimes infested, and under these and certain other conditions the use of sodium fluoride can be depended upon to eliminate the trouble very shortly.

In conclusion, a word more should be said about the sanitary conditions of establishments under government inspection and those without adequate inspection. While meat bearing the stamp of government inspection is sometimes sold slightly higher than uninspected meat, there is certainly a marked difference in the value of the product, from the standpoint of the consumer, and possibly some difference in the cost of production. It may be of interest to know that the Bureau of Animal Industry reports that over 62,000,000 animals were inspected in the 875 establishments under government inspection during the fiscal year ending July 1, 1916. It is estimated that over 40,000,000 animals are slaughtered on the farm and by small butchers, all of

which received no inspection. On account of the intermittent killing on farms, the fly conditions there are far less objectionable than in the small slaughter houses. The fly conditions in most abattoirs not under inspection are beyond description, and one need but to pass through one of these and one of those plants receiving proper inspection to be convinced of the undesirability of buying uninspected products and the need of state or municipal control over such establishments. It may be said that most of the fly control measures found applicable for use in government inspected plants are equally so in the uninspected ones though some modification is often necessary. The first step toward mitigation of the fly trouble is to secure effective supervision and control over such plants. Where incineration is not feasible, prompt burial under two feet of soil after the offal has been sprinkled with borax, the thorough screening of buildings and the installation of covered drains will accomplish much in reduction of fly numbers.

WORK ON WHITE PINE BLISTER RUST IN MINNESOTA, 1916

By F. L. Washburn

Abstract

The rust has been discovered in four places only along the eastern boundary of Minnesota, close to the St. Croix river, two of which are nursery infections. One of these nurserymen is known to have brought diseased trees from an old nursery in Wisconsin, just across the river, said trees being a portion of a lot shipped through Hill of Dundee, Ill., to a Wisconsin nurseryman in 1908 or 1909. We have worked in close coöperation with the Plant Pathology Department, aided in part by the State Forestry Service. Camp was established on the St. Croix river, and scouting under the direction of the State Entomologist was carried on up and down the river for a distance of about fifty miles, with the results as above stated. In the two nurseries mentioned, all five-leaf pines and all currants and gooseberries were destroyed by burning, said nurseries being under quarantine as regards this material until destruction of same. Shipments from these nurseries designated as "leads" were traced and destroyed wherever the slightest suspicion was entertained of the presence of blister rust. In the neighborhood of Dry Creek eradication area was outlined and all Ribes within the area as far as possible destroyed by workmen and experts in the employ part of the time by the State Entomologist and a portion of the time by the federal government, although federal funds

were used more particularly in the survey work. Precautions were taken to prevent the spread of spores on the part of workmen by spraying the workmen at the end of working procedures with a weak solution of formaldehyde. All four of these infections lay within a distance of 50 miles along the St. Croix river. The last infection at Pine Hollow Creek was found late in the season at the time of the first frosts, so eradication of Ribes at that time was not practical.

We believe Minnesota has a reasonable hope of eradicating the disease within its borders, and to that end the legislature is being pushed, and appropriation asked for from our state legislature. In planning the work for next year, we are promised coöperation on the part of Wisconsin authorities and it has been recommended that the work in Minnesota be arranged in such a way as to give to the Plant Pathologist with the coöperation of the State Forest Service, the eradication of diseased or dangerous material along the St. Croix, and survey and eradication in nurseries, parks and cemeteries and private plantings to the State Entomologist.

(This address was illustrated by lantern slides.)

NOTES ON AN INTRODUCED WEEVIL (CEUTORHYNCHUS MARGINATUS PAYK.)

By J. A. Hyslop, *Bureau of Entomology, Washington, D. C.*

In sweepings from a mixed meadow at Bridgeport, N. Y., on the southern shore of Lake Oneida, early in the spring of 1914, large numbers of a small weevil which I then took to be *Rhinoncus pyrrhopus* Lec., were found, particularly from those parts of the field where weeds predominated. Knowing that *Rhinoncus pyrrhopus* lived in the stems of *Polygonum spp.*, no further attention was given to these beetles.

In May, 1916, while supervising the construction of an experimental tile drainage system at the same point, the writer's attention was called by Messrs. C. E. Ellis and C. D. La Rue of the State School of Forestry, who were then studying the flora of the experimental plat, to some small larvæ feeding on the seed of dandelion (*Taraxacum officinale* Web.). The insects proved to be the European weevil *Ceutorhynchus marginatus* Schonh., at that time unrecorded from this country. Since preparing this paper Blatchley and Leng have published their monumental work on North American Rhynchophora. In this work the species is first recorded from North America, being taken in Massachusetts, etc., and having been reared from dandelion

by Prof. Glen W. Herrick at Ithaca, N. Y. Mr. E. A. Schwarz, of the U. S. National Museum, very kindly determined this material and in doing so remarked that he had collected the adults on Plummer's Island near Washington, D. C., about ten years ago. On reëxamining the material collected in 1914, it also proved to be this beetle and not *Rhinoncus pyrrhopus* for which it was originally mistaken. The outbreak at Bridgeport was very general, nearly every seed head of the dandelion being infested, which seems to indicate that the insect has been established there for several years. Mr. Schwarz's record from Maryland and the records published by Blatchley and Leng indicate a wide distribution in the Eastern States. That this insect should be established for so long a time and in so wide and generally collected a territory and still be unrecorded seemed quite remarkable. The genus contains other species of economic importance, among which might be mentioned *Ceutorhynchus rapæ* Gyll., the common cabbage weevil, *C. quadridens*, another introduced species which Chittenden records attacking radish, cabbage, carrots, etc., on Long Island, and the new species recorded and described by Pierce[1] (*C. lesquellæ* Pierce) which is a serious cabbage pest in Texas. The only published European observations on the habits of this beetle, those of J. H. Kawall published fifty years ago in the *Stettener Entomologische Zeitung*,[2] are so minutely paralleled by our observations that I herewith publish a free translation.

The species *C. marginatus* Payk. was long recognized as a variety of *punctiger* Schonn, the more recent workers now recognize the insects as a distinct species, and from the localities we conclude that the one spoken of by Kawall as *punctiger* was in reality *marginatus* Payk.

"As early as 1859 I had noticed on the seed heads of *Taraxicum officinale* Wigg. (the dandelion), which had split open and spread out their seed feathers, and after the seed had blown away, that the fruit receptacle was often stained with brown on the upper surface and eaten out cavities were to be seen. I had not, however, found the originator of this damage. At last I had the good fortune to find a seed head in an opening in the seed capsule of which a footless whitish maggot had wedged itself. I placed this find in a box but the little animal failed to transform, the maggot shrivelling up probably from lack of moisture. The following year I searched vainly for such larvæ. Eaten out fruit capsules were easily to be found but were always empty. Notwithstanding this I again began the fruitless search in May, 1861. I continued to examine the completely opened heads and also the unopened buds. I then began to examine the seed heads upon which the shrivelled petals were still adhering but which could be knocked off with a very slight touch, these seed heads were still closed.

[1] Journ. Econ. Ent. vol. III, p. 366, 1910.

[2] Stett. Ent. Zeit., vol. XXVIII, p. 118, 1867.

The seed was nearly ripe but had not yet expanded. Here I found the larvæ in the seed capsules, they had eaten out the inner half and themselves occupied the space from which they had removed the contents. I found two or three larvæ in a seed head, these left the seed, as soon as the latter spread out, and fell to the earth into which they crawled and pupated. The development to the imago does not take place in the seed heads. At first I thought I would obtain from these larvæ *Trypeta leontodontis* and hoped to get some accurate information on the metamorphosis of this boring fly about which Löw has said, 'It is for *Trypeta leontodontis* that a very distinct food has been given, not the same it is certain as that of the closely allied species which are placed together here. (Alleg. Nat. Zeit. IV, 1847, p. 295.) The results were very different, however, as these larvæ proved to be coleopterous. The larva is footless with wrinkled folds, the segments being whitish $1\frac{1}{2}''$ long, when outstretched in crawling $2''$ long and $\frac{1}{2}''$ in diameter; head golden brown, mandibles darker, head small and roundish not as wide nor as high as the body; body narrowed from front to back, naked.

"There emerged from larvæ which left the seed heads on the 30th of May, six specimens of a beetle on June the 26th and these were *Cœliodes* (*Cryptorhynchus*) *punctiger* Schh. The time of transformation was from 27 to 28 days. On the 8th of June, 1863, I found ten larvæ of these beetles in the seed head of this plant, and in the heads of the same plant at the same time, I also found the seed eaten out by another larva. These latter are $1\frac{1}{2}''$ long, darker than *C. punctiger* with a blackish head, sharply constricted segments and three pair of blackish legs. They wedged themselves very tightly between the seeds and were whitish in color. Rearings of these gave beetles of *Olibrus bicolor*."

On June the 8th, 1916, I collected one hundred and twenty flower heads of dandelion that had but recently finished blooming. The blossom closes tightly (Fig. 14 *g*), just prior to throwing off the withered petals and expanding the seed carriers into the characteristic nebulous globe with which we are so familiar, and it is at this time that the larvæ are most easily found in the flower heads. When the seed heads open, they crawl out, drop to the ground and burrow down about the base of the plant to a depth of approximately one-half inch where they construct small oval earthern cells, which can easily be removed from the surrounding earth without crushing (Fig. 14 *k*), in which they pupate. Infested seed heads can easily be recognized by the black exudations on the outer surface of the calyx (Fig. 14 *g*), probably caused by the entrance of the young larvæ or oviposition. The larvæ feed principally on the seed (Fig. 14 *h*, *i*, *j*) but on several occasions larvæ were found among the withered flower petals. Seventy of these flower heads were dissected to determine the amount of damage the insects were doing. From these dissections we found that the average number of larvæ in a flower head was 3.7, the percentage of seed damages being 27.6.

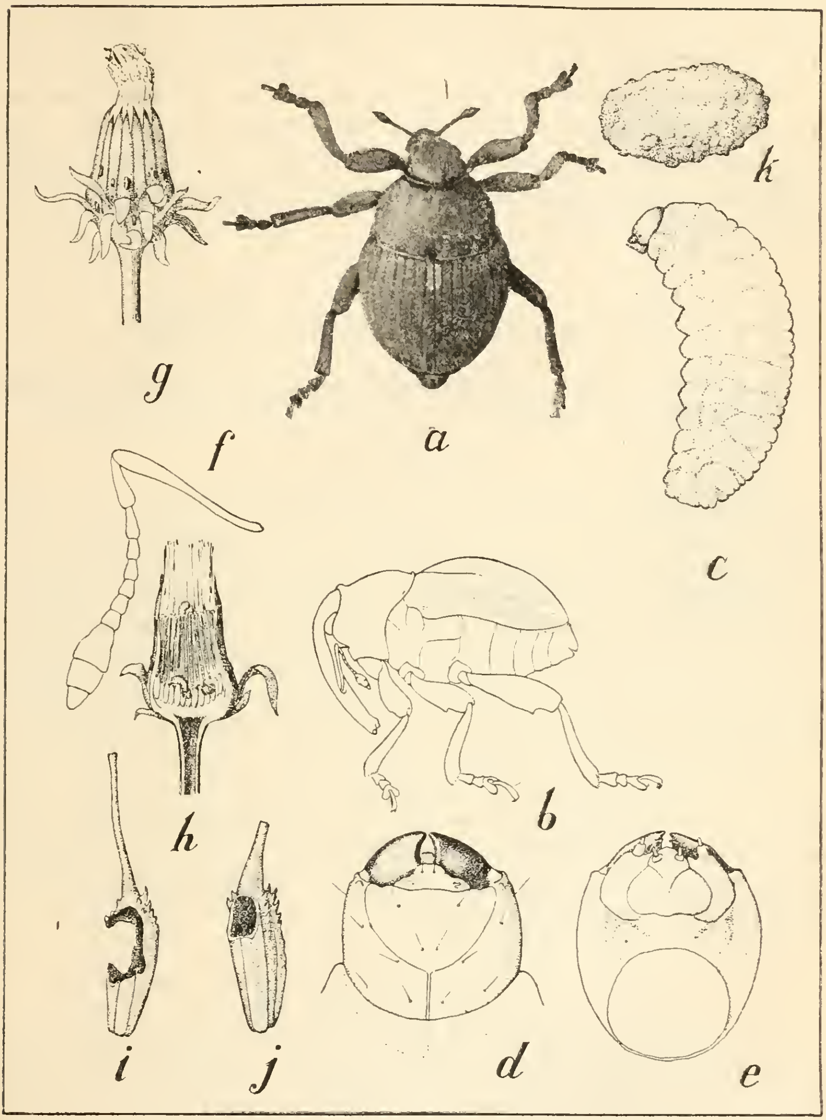

Fig. 14. An imported weevil (*Ceutorhynchus marginatus* Payk.). *a*. Adult, dorsal aspect; *b*. lateral aspect; *c*. larva, lateral aspect; *d*. larval head, dorsal aspect; *e*. ventral aspect; *f*. adult antenna; *g*. dandelion floral head containing weevil larvæ; *h*. sagittal section of same; *i*. and *j*. individual damaged seeds; *k*. pupal cell.

By the first of July all the adults had emerged. The locality was revisited on October 20th at which time adult beetles were to be found under the litter at the base of the dandelion plants and undoubtedly these insects hibernate as adults.

An insect which can destroy approximately one-quarter of the seed crop of a noxious weed is no small factor in farm economics. The dandelion, on the other hand, is now quite extensively used as a green vegetable in certain parts of the country and here the insect in question when abundant will be a crop pest.

THE TWO-BANDED FUNGUS BEETLE[1]

By F. H. Chittenden, Sc. D., *In Charge of Truck Crop and Stored Product Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

Introduction

Among species of tenebrionid beetles which habitually frequent mills, granaries, and other storehouses is a species belonging to a different group from any of the several flour beetles, the tribe Diaperini, which is mostly composed of species which live on fungus or dead or decaying vegetable matter—the two-banded fungus beetle (*Alphitophagus bifasciatus* Say). This species, though now cosmopolitan and credited with exotic origin, would appear to be one of the few cosmopolites native to America, from which country it was described by Say in 1824 (1). This origin, however, is decidedly doubtful.

In 1832 it was redescribed by Stephens (2) from England under the name of *Alphitophagus quadripustulatus*, the genus having been especially erected for this species. It has only been in somewhat recent years that the identity of *Phylethus bifasciatus* Say with the European form has been established.

Descriptive

The Beetle

In appearance this pretty little beetle, shown in Figure 15, resembles some of the fungus-eating Mycetophagidæ, to which family belongs *Typhœa fumata*, an insect of similar habits, more than it does any of the other farinivorous Tenebrionidæ. In form it is elongate oval, convex, depressed, and a little less than one eighth of an inch long. Its color is red brown, with two broad black bands across the elytra or wing-covers.

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[1] Published by permission of the Secretary of Agriculture

Since the writer's experiments on this species seem to establish it as innoxious, its description will be limited to the original characterization of the genus and of the species by Stephens and Say, respectively, which are here transcribed.

The Genus

Genus *Alphitophagus* Steph.

Antennæ slightly elongate, and a little increasing in stoutness to the apex, 11-jointed, basal joint robust, second minute, third and fourth of nearly equal length, slightly elongate, fifth and sixth also equal, stouter and somewhat cup-shaped; four following subquadrate, a little produced within, and thickened at the apex, terminal subglobose, largest. Palpi short, with the terminal joint slightly thickened, somewhat triangular; mentum subcordate; head suborbiculate: thorax transverse, rounded in front, convex: body oval, convex; elytra free; wings ample: legs slender; tibiæ simple, all similar; tarsi heteromerous, with entire joints. (Stephens (2).)

The Species

Alphitophagus bifasciatus Say

Body reddish-brown, punctured: head reddish-black: eyes black: palpi whitish: thorax with a dusky obsolete spot on the middle, and another on each side; angles rounded; punctures very minute, dense: elytra yellowish-fulvous, with punctured striæ; a broad band in the middle, another near the tip, and scutellar region, black: feet pale reddish-brown. (Say (1).)

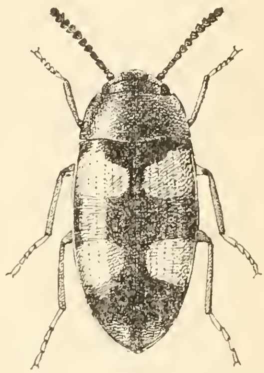

Fig. 15. *Alphitophagus bifasciatus.* (Original.)

Synonymy

The following synonymy is recognized by Seidlitz:

Alphitophagus bifasciatus Say

? *Diaperis bifasciata* Say (1), Journ. Ac. Phil., vol. III, p. 268, 1823.

Diaperis picta Ménétriés (1), Cat. rais., p. 203, 1832.

Alphitophagus quadripustulatus Stephens-Illus., Brit. Ent. Mand., vol. V, p. 12, 1832.

Neomida picta Faldermann-Fauna Franscauc, vol. II, p. 65, 1837.

Phylethus populi Redtenbacher (1), Fauna Austr., p. 589, 1849.

Phylethus quadripustulatus Mulsant (1), Col. Fr., Latig., p. 204, 1854.

Alphitophagus bifasciatus Hamilton (1), Entomologica Americana, vol. VI, 1890.

Biologic Notes

Aside from two notes published in *Insect Life*, (10), (12), the notes in this Bureau are limited. In the writer's personal experience with the species in and about the city of Washington, it has often been found in spoiled cereals and sweepings from the floors of feed stores, and in one instance the writer found specimens, April 29, in spillings of bran and similar material that had fallen through the cracks of a

railway station platform used for the reception of grain, flour, and feed at Branchville, Md.

During July, 1898, correspondence was had with a milling company at Mt. Pleasant, Iowa, in regard to several species of grain insects, of which this insect was one. September 25, 1906, the late M. V. Slingerland sent this species in a lot of mill products from Plattsburg, N. Y. which was also infested by the European grain moth (*Tinea granella* L.).

Mr. Schwarz informs the writer that at Dallas, on the Hood River in Oregon, the species is often found out of doors, being commonly beaten from bushes and found running on the sand, and that in the District of Columbia it inhabits a fungus growing upon trees.

In the streets of Washington, D. C., the beetles occur in great numbers on the window-panes of stores, where they are attracted by the electric lights. The beetles are comparatively active, free runners and flyers.

A number of experiments were made by the writer to ascertain the true habits and life-history of the species. Beetles taken at electric light and placed in dry cornmeal June 13 perished without any larvæ developing. Beetles afterward placed in cornmeal, which was kept moist and in which fermentation took place, lived for a long time and several generations were developed. That a considerable degree of moisture is necessary to this species when in an immature condition was proved when in the course of dry experiments all died and shrivelled up in a very short time. Even a portion of those which were confined in vials fitted with rubber stoppers met with a like fate.

At one time beetles were placed in fermenting cornmeal (May 10) and a new generation was produced in 38 days; the weather being cool, will account for the period.

In a rearing of fermenting meal and flour in which the beetles were placed on June 22, a new generation of beetles was produced in 32 days. During half of this time the weather was unseasonably cool, but it was ascertained by means of a thermometer that the temperature of the rearing jar was about 10° F. warmer than that of the room in which the experiment took place.

The eggs were not observed, but the pupa period was ascertained to be six days in the hot weather of August. Allowing six days for the probable period of the egg, this will give a larval period of between three and four weeks for ordinary summer weather.

Literature

The literature of this species is practically limited to descriptive matter and to brief notices of habits or occurrence.

Mention of its habits was made by Stephens in 1832 (2), who stated that the types of *quadripustulatus* were reared from flour, and that the species was also found "in the decaying floor of a malt house in Cambridge (England)."

Mulsant (4) recorded the capture of the insect under bark; Duval (5) stated that it occurred in débris gathered in a stable; Redtenbacher (6) wrote that it lives under decaying vegetable matter; E. A. Fitch (7) and others that it was found in "corn" (presumably wheat) in storehouses and granaries in England.

Schioedte (9), who gave a description of the larva and pupa with illustrations, states briefly that the species lives in storehouses, in flour and in bread.

What appears to be the earliest mention of its occurrence indoors in the United States is that published by this Bureau in 1889 (10). This is in the form of extracts from correspondence with McPherson & Stevens, Sprague, Wash. Our correspondents stated that this insect seemed to breed under basement floors and to come up and fly away on warm days. The insects did not appear to work in wheat bins but rather in flour dust in dark places. They were stated to be present all the winter and spring and at the time of writing were very numerous.

Several remedies were tried and Persian insect powder was found to be effective.

Prof. L. Bruner, writing in 1893 (11) stated of this species, which he included in a list of insect enemies of small grain, that if it were allowed to increase unmolested it might become a very troublesome pest.

The species is included in a list of insects observed in stored products exhibited at the Columbian Exposition at Chicago, in 1893 (12). The observation was made by Mr. E. A. Schwarz, who noticed the beetles in dried fruit from one of the Central American countries.

Summary

This minute insect as its name, fungus beetle, would indicate, is a feeder on fungi such as molds and has never been actually observed attacking perfectly fresh material. It is a scavenger and is usually found in refuse, such as decaying vegetable matter, in flour and feed stores, in mills and in grain warehouses, and is not uncommon in the open as well as indoors.

It requires a considerable degree of moisture for development and is capable of developing in ordinary summer weather in the District of Columbia in about the same time as other indoor insects of its size—in four to six weeks.

It has been observed in flour, corn meal, bread and under bark and in decaying wood and some other material, including dried fruit. It is cosmopolitan and, although abundant nearly everywhere, is not often reported in great numbers.

Control

As to remedies, the species is hardly worth considering. It has been noted above that Persian insect powder has been found effective. When storehouses, mills, stables and other buildings where stored materials are kept contain other insects which are injurious, this species will, of course, succumb to standard remedies such as fumigants and heat.

It should be unnecessary to add that the insect would not be apt to multiply in any great numbers if scrupulous cleanliness of buildings is maintained.

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(7) Fitch, E. A. The Entomologist, vol. XII, p. 45, 1879. Included in a list of insects observed in a London grain warehouse.

(8) Billups, T. R. The Entomologist, vol. XII, p. 268. 1879. As in the preceding.

(9) Schioedte, J. G. Naturh. Tidsskrift, vol. II, pp. 505, 515, 555, 557, 586. Tab. IX, figs. 17–27, 1879. Descriptions of larva and pupa with original illustrations.

(10) Correspondence. Insect Life, vol. II, p. 21, 1889. Occurring in flour dust in mill at Sprague, Washington. Persian insect powder efficacious.

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FURTHER TRIAL OF SULPHUR-ARSENATE OF LEAD DUST AGAINST THE STRAWBERRY WEEVIL[1]

By Thomas J. Headlee, Ph.D., *New Brunswick, N. J.*

Last year before this Association it was shown by the writer that sulphur-arsenate of lead dust when maintained as a rather complete coating from the time bud-cutting begins until most of the buds have opened gives, in the case of the Heritage variety, almost complete protection from the strawberry weevil (*Anthonomus signatus* Say). It was stated at that time also that the protective action seemed to be due to a repellent effect.

The results were so surprising that confirmatory tests were planned for the season of 1916. The tests involved the treatment of strawberries on at least two farms in each of three counties. The plots to which the writer gave most careful attention were located on the farm of Mr. William Oeser of Cologne, N. J.

Mr. Ellwood Douglass ably and conscientiously assisted in the tests at Cologne and took charge of those elsewhere in Atlantic County, while Mr. Warren Oley and Mr. George T. Reid performed the same tasks in Cumberland and Burlington Counties, respectively. While a large measure of protection was obtained in each of the counties included in the tests, the best results were had on the plots on Mr. Oeser's farm.

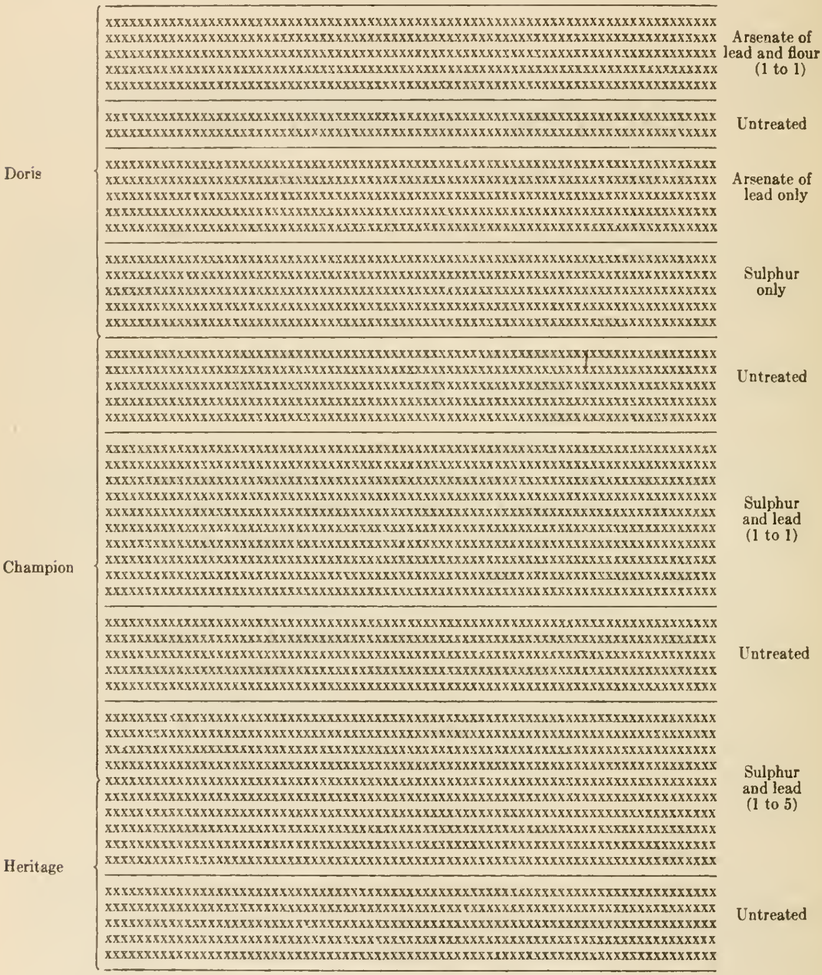
The arrangement of the plots in this test are shown in the accompanying diagram.

At this point the first treatment was given before the Champion buds had hardly appeared and just as injury began on the Heritage. Considering the lateness of the Champion it seemed advisable for the sake of thorough protection to dust three times instead of two as is usual in dealing with a single variety. The dusts were applied with a Tow-Lemons one-man dust gun but the experience with it demonstrated the need for traction or power machinery in dealing with

[1]Contribution No. 2 from the Entomological Laboratory of Rutgers College and the N. J. Agr. Expt. Stations.

large areas. Fairly good results on small areas were had among neighboring farmers by applications through a cheese cloth bag or even by the hand alone.

The results of the treatments in this test are set down on an acre basis although the whole patch amounted to only two acres.



This year the number of buds cut in the treated plots after the treatments began increased to greater extent than it did last year. The writer believe this to be due to less careful covering incidental to making the applications on a commercially practicable plan. The mixtures are shown to be decidedly more effective than either of the

Place	Treatment		Variety	Percentage of buds			Comparative yield	Increase due to treatment	Value	Estimated cost of treatment	Net Return
	Nature	Time		Clean	Stung	Cut					
Cologne	Untreated		Heritage	17.7	31.5	50.7	442 qts. per acre				
Farm of Mr. Wm. Oeser	Arsenate of lead 1 part, sulphur 5 parts	5/6, 5/12, 5/19	Heritage and Champion	62.7	19.2	18.0	2,442 qts. per acre	1,610.5 qts.	$128 84	$12.00	$136.84
	Untreated		Champion	52.7	20.6	26.7	1,221 qts. per acre				
	Arsenate of lead 1 part, sulphur 1 part	5/6, 5/12, 5/19	Champion	78.	12.2	9.0	2,604 qts. per acre	1,532 qts.	$122.56	$24.00	$98.56
	Untreated		Champion	56.7	14.5	28.8	903 qts. per acre				
	Sulphur	5/6, 5/12, 5/19	Champion and Doris	58.5	14.7	26.8	1,313 qts. per acre	481.5 qts.	$38.52		
	Arsenate of lead	5/6, 5/12, 5/19	Doris	71.2	15.8	13.0	1,106 qts. per acre	343 qts.	$27.44		
	Untreated		Doris	57.5	15.5	27.	760 qts. per acre				

constituent substances, and this, it is thought is due to the more complete coating effected by the mixture because of its better flowing qualities. The one to five mixture is equally as good as the one to one and much less expensive.

The increase in crop obtained by the applications is about 200 per cent. In the other tests the increase ranged from barely perceptible when the bud cutting on the check was low to more than 100 per cent when it was high.

The returns at Cologne, while larger than those obtained elsewhere, are due to the maintenance of a more complete coating of the buds during the critical period, and should be susceptible of being duplicated or bettered when sufficient care and intelligence are employed.

LITTLE KNOWN WESTERN PLANT LICE. II

By W. M. Davidson, *U. S. Bureau of Entomology, Walnut Creek, Cal.*[1]

Vacuna dryophila Schrank (?). Figs. 16, 1 to 3.
Chaitophorus sp. Davidson, Jour. Econ. Ent., Feb., 1914, p. 128.

The apterous vivipara (erroneously thought at the time to be the stem mother) and young sexual were described by me in 1914 under the name of *Chaitophorus* sp., the young sexual somewhat resembling the spinous dimorphic forms found in the *Chaitophorinæ* in species living on maple and box elder. However, after other forms had been encountered it became obvious that the species was widely separated from *Chaitophorus*, and that it belonged to a small group in which the sexes are small and wingless and in which the true female deposits normally but one winter egg. In their sexual characteristics the *Vacuninæ* approach the *Schizoneurinæ* and *Pemphiginæ* but the habits of the other forms more nearly approach those of the *Chaitophorinæ* and the *Lachninæ*.

In the species with which we are concerned the stem mothers hatch about the beginning of March, at a time when the buds of the oak have not perceptibly swollen. The lice feed at the base of a bud and are at first dark olive green with erect white spines. As they grow they become darker and mature individuals are brown. They remain at the base of the bud and produce a generation of young which become apterous viviparæ and in turn give birth to the third generation. Some of the third generation become nymphs and later acquire wings. The second and third generation apteræ are bright green with antennæ and legs pale hyaline greenish white. The pupæ are similar in color

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and have in addition, at the base of the abdomen, two pairs of conspicuous yellow areas. The second generation matures about the second week in April and the third generation about the beginning of May. The nymphs are apparently not abundant and the single winged specimen I have collected may be described as follows:

Head, thorax, scutellum, sternal plates dark olive green, shining; antennæ and legs pale yellow hyaline, the two basal antennal joints dark olive green as the head; eyes red, compound; prothorax, wing insertions, abdomen yellowish-green; cornicles brown; cauda pale green; wing veins brown, narrowly bordered dusky; beak pale, apical third dusky; head evenly rounded in front as in apteræ; eyes and ocelli prominent. At the base of each antenna, intad, on the margin of the head is an acute pale tubercle of about the size of the central ocellus. Antennæ about half the body in length, 5-jointed, III sub-equal to IV and V combined; beak reaches third coxæ; thoracic lobes partly fused; wings carried horizontal, third discoidal vein unbranched in one wing and with a branch at apex in the other; hind wing with one discoidal; cornicles pore-like; cauda small, globular; abdomen robust. Measurements (balsam mount); length body .75 mm.; width body .36 mm.; antennæ .39 mm. Date of collection, May 16, 1915.

The above-described individual was submitted to Mr. A. C. Baker, U. S. Bureau of Entomology, Washington, D. C. Mr. Baker has pointed out the following differences between it and European specimens of *V. dryophila* in the U. S. National Museum collection: Typical *dryophila* has four circular sensoria and about 12 prominent hairs on antennal III, while the California specimen has no sensoria and not over 3 hairs; the thorax of typical *dryophila* is without any indication of lobes, whereas the California individual has the thorax partly divided into lobes.

The spring colonies of apteræ are greedily attended by ants and from their very gregarious habits fall easy prey to predators. After May the only forms remaining are the young sexuals which are deposited by the alatæ of the third generation during May. The spring colonies feed both on the stalks and on the lower leaf surface but the sexes only in the latter location. The sexuals are often quite abundant and are not so gregarious as the spring forms. Although deposited in May they do not cast their first skin until September and are not mature until the latter part of November.

The full-grown insects are of a pale lemon color with greyish antennæ and legs, and the cornicles appear as brown-rimmed pores. They are armed with thick spines. The eyes are simple, of 3 facets. The last antennal joint is markedly longer than the penultimate and about as long as III. It bears a fringed sensorium. The beak reaches to the second coxæ. The male measures about .51 mm. by .23 mm., antennæ .21 mm., the female about .85 mm. by .44 mm., antennæ .23 mm. After mating the female deposits a single egg in the axils of the buds. This egg is oval, black, lightly covered with silvery filaments previously noticeable on the sides of seventh and eighth abdominal segments of the female.

This species I have observed at Walnut Creek, Calif., on the valley oak (*Quercus lobata* Née) from the spring of 1913 to 1916. The insect is quite local and does not appear to spread appreciably, perhaps due to the scarcity of alates. In California there is a species on alder (*Alnus rhombifolia* Nutt.) which apparently belongs to the same group of aphides and of which I have thus far taken only the ovipara (Stanford University, Nov., 1914, and Hopland, Sept., 1915). In color and shape this resembles the oak species but it has a different arrangement and structure of spines.

Callipterinella annulata Koch. Figs. 16, 4 to 8.

Chaitophorus annulatus Koch. Die Pflanzenlausen.
Chaitophorus betulæ Buckton. Brit. Aphid. II.
Chaitophorus betulæ (Buckton) Gillette. Journ. Econ. Ent., Aug., 1910.
Callipterinella annulata (Koch) Van der Goot. Zur Systematik der Aphiden. Tijd. voor Ent., 1913.

Considerable doubt has arisen about the placing of this species and in 1913 Van der Goot erected the new genus Callipterinella to contain it and *Callipterus betularius* Kalt. This latter species I have never seen but *annulata* has characters of *Myzocallis* of the Callipterini (cornicles, antennal armature, etc.) and others of *Thomasia* of the Chaitophorini (cauda, non-capitate hairs, length of antennæ, etc.), but it cannot rightly belong to either. Van der Goot has placed it in the Callipterini which seems its right place, and whether or not his scheme of genera be accepted *in toto* there can hardly be any doubt concerning the validity of the genus *Callipterinella*, as far as the species *annulata* is concerned. The synonymy of Buckton's *betulæ* is taken from Van der Goot.

According to Gillette (J. E. E., Aug. '10) this species has a wide distribution in America for it is reported by him from Portland, Lansing, Albany, Geneva and Denver. In California it occurs together with the European *Euceraphis betulæ* on imported Birch (*Betula alba*) infesting foliage and shoots. The prevailing color is reddish-brown.

Apterous viviparous female (Fig. 16, 4). Reddish-brown: body clothed with numerous long non-capitate hairs; many dark brown transverse bands and lateral sub-circular and sub-quadrate areas occur on the dorsum: antennæ basally light-colored, apically dark brown, half as long as the body, clothed with short hairs; III with 4 to 5 oval sensoria in a row on the slightly swollen basal half: hairs on forehead as long as antennal segments I and II combined: legs quite hairy; tarsi dusky, rest concolorous with the body ground color: cornicles dark brown, sub-quadrate, .071 mm. long, .068 mm. wide at base: cauda hardly constricted basally, rounded, dusky, .070 mm. long: anal plate dusky, emarginate: beak stout and short, reaching anterior margin of second coxæ. Length of body 1.83 mm. Width of body (fifth abdominal segment), .71 mm. Antennæ; III .39 mm., IV .20 mm., V .17 mm., VI .10 mm., filament .19 mm.

Oviparous female (Fig. 16, 5). Light reddish-brown: body clothed with numerous long non-capitate hairs: head, prothorax and a broad transverse band on each of the remaining body segments dark brown; each of these segments has also a pair of lateral sub-quadrate brown areas, noticeably large on mesothorax, metathorax, and abdominal segment 8: antennæ about half as long as the body, dark brown, basal seven-eighths of III and basal half of IV pale yellow; III thickened basally and on this swollen portion are 3 to 5 oval sensoria in a row: legs dark brown, base of femora and middle part of tibiæ pale yellowish-brown; legs hairy: under side of abdomen marked with rows of small faint brown spots: beak pale, apex brown; barely reaches second coxæ: cornicles dark brown, subquadrate, .093 mm. long, .082 mm. wide at base; cauda pale reddish brown, obtusely conical, .066 mm. long: anal plate rounded: hind tibiæ bear on their slightly swollen basal half a great number of small circular sensoria: length of body 2.48 to 2.89 mm. Width of body (fifth abdominal segment) 1.07 to 1.22 mm. Antennæ; III .54 mm., IV. 29 mm., V. 21 mm., VI .15 mm., filament .27 mm.

Male (Fig. 16, 6–8). Ground color reddish brown. The single specimen I have is almost destitute of hairs except on the legs and at the extremity of the body: brownish transverse bars, not reaching margins, occur on disk of abdomen and spots of similar color occur on lateral margins: abdominal segments 1 to 5 have 2 pairs of small lateral tubercles, the inner pairs the larger: antennæ almost as long as body; on both there are 17 circular sensoria on III and these occupy in a row the entire length of the joint; V and VI have each an unusually large apical sensorium and VI has besides about 3 small ones; the sensoriation similar to that of the male of *Calaphis betulaecolens* Fitch in that the fourth joint is unsensoriated: beak reaches halfway between second and third coxæ: veins of the wings thick and somewhat narrowly clouded; stigmatic vein obsolete for its basal half: legs with short hairs: cornicles dusky brown, subquadrate, .07 mm. long: cauda rounded, slightly constricted basally, grey: anal plate emarginate: length of body 1.92 mm. Width, maximum .73 mm. Antennæ; III .52 mm., IV .29 mm., V .24 mm., VI .12 mm., filament .24 mm.

Male and apterous female taken the first half of October, 1913, at Oakland, Cal. Oviparous females taken October 23, 1915. at Walnut Creek, Cal.

Aphis neo-mexicana Ckll. var. *pacifica* var. nov. Fig. 16, 9 to 14.

Alate viviparous female (Fig. 16, 9–11). Light green: head and prothorax olive-grey: antennæ black: thorax brownish-olive: cornicles and cauda light grey: beak pale, tip black: abdomen light green with lateral rows of circular black spots: veins of wings brown, narrowly clouded; stigma and insertions greenish: legs yellowish-brown, tibial and femoral apices and tarsi black: sterna black: anal plate grey: eyes dark red. Antennæ not on frontal tubercles, reaching to the fifth abdominal segment; filament longer than III; IV and V sub-equal; sensoria circular, of irregular size and those on III not disposed in a row, 11 to 14 on III, 4 to 6 on IV, usual apical on V and VI except that occasionally on V there are 1 or 2 extra about the middle of the segment: prothorax bears a pair of lateral tubercles: beak reaches to third pair of coxæ: second fork of third discoidal vein slightly nearer to the wing apex than to the first fork: seventh abdominal segment bears a pair of lateral tubercles: cornicles imbricate, slightly enlarged at base, longer than antennal joint IV but not as long as III: cauda of the usual shape of the genus, rather large, two-thirds the cornicles in length, armed with spines. Length of body 1.2 mm. to 1.3 mm. Maximum width .46 mm. to .56 mm. Wing expanse about 5 mm. Beak .46 mm. Cornicles .17 mm. to .2 mm.

Cauda .14 mm. Antennæ; III .21 mm. to .26 mm., IV .14 mm. to .17 mm., V .14 mm. to .17 mm., VI .11 mm. to .12 mm., filament .27 mm. to .31 mm.

APTEROUS VIVIPAROUS FEMALE (Fig. 16, 12–14). Light green: antennæ, legs, cornicles, cauda hyaline greenish white; knees briefly and antennal VI entirely, dusky grey; eyes red: prothorax with prominent lateral tubercles: a pair also on seventh abdominal segment: beak pale, apex dusky, reaching beyond second coxæ. Length of body 1.23 mm. Width .67 mm. Cornicles .27 mm. Cauda .19 mm. Antennæ; III .16 mm., IV .14 mm., V .13 mm., VI .11 mm., filament .21 mm. The pupa is pale green with light-colored wing-pads.

This species was taken at Walnut Creek, Cal., curling terminal leaves of cultivated red currant in June, 1915. What appears to have been the same species was collected at San Jose, Cal., in May, 1912, on the same host. Mr. A. C. Baker, Washington, D. C., to whom specimens were sent, compared these with the type of *A. neo-mexicana* Ckll. and has written that the two varieties are very similar except that the California specimens have a longer distal antennal joint and slightly larger sensoria. The species is evidently near *Aphis sanborni* Patch and *Aphis ribis* Sanborn. It differs from the former in the comparative lengths of antennal joints and cornicles and from the latter in its comparatively longer beak and in the sensoriation. The infestation at Walnut Creek was confined to a single small currant bush and was first noticed about the end of May. Before the end of July the lice had been entirely wiped out by predators. Late in the fall a few oviparæ of a species of *Aphis* were observed on the bush, but the species could not be identified. At the same time migrants and sexes of *Myzus cynosbati* Oestlund occurred on the plant.

Type: U. S. National Museum Catalogue No. 20072.

Myzus ribifolii sp. nov. Fig. 16, 15 to 28.

STEM MOTHER (Fig. 16, 15, 16). Stout and broad; ground color pale green; head, band of prothorax, thorax, and disk of abdomen brownish-black; the lateral margins of the abdomen and that part of the disk caudad of the cornicles (except a median band on seventh segment) pale green; the dark color predominates; under side of body pale green; cornicles, tip of cauda, coxæ, trochanters, knees, tibiæ and tarsi dark brownish-black; antennæ pale green, articulations dusky brown: antennæ on obvious frontal tubercles which are slightly gibbous; first joint rather obscurely toothed; antennæ from half to two-thirds the length of the body; III longer than the filament of VI, but shorter than whole of VI; V slightly exceeding IV; beak pale, tip dusky, reaches to second coxæ: cornicles imbricated for their entire length, slightly thickened at base: cauda slightly shorter than cornicles, ensiform, the apex rather bluntly rounded: hairs on forehead and antennæ long, those on body and legs shorter, in all places moderately abundant, very indistinctly capitate. Length of body 2.13 mm. Width (metathorax) 1.30 mm. Cornicles .21 mm. Cauda .19 mm. Beak .50 mm. Antennæ; III .27 mm. to .29 mm., IV .16 mm., V .17 mm., VI .09 mm., filament of VI .23 mm.

Stem mothers were collected at Redwood Canyon, near Walnut Creek, Cal., towards end of March, 1915, in curled and blistered foliage

of the wild flowering currant (*Ribes glutinosum* Benth.). In most of the curled leaves but one insect occurred and it is presumable that a single individual was able to bring about the malformation. The leaves bore noticeable yellow and pink blisters recalling those caused by *Myzus ribis*.

Apterous viviparous female, second generation (Fig. 16, 17–19). Yellowish-green in ground color, marked very much as is the stem mother, but some individuals lack the dark brown markings and have only orange-colored areas about the base of the cornicles; antennæ basally pale, apically dark brown; cornicles and cauda brownish-black; coxæ and tibiæ dark brown; 4 anterior femora greenish-yellow; posterior femora black, the basal half greenish-yellow; tarsi dark brown; antennæ reach to base of cornicles, relatively longer than those of the first generation but similar in structure; III bears on its basal half 4 to 7 sensoria; IV is longer than V; III and filament of VI sub-equal: cornicles and cauda much as in stem mother, shape of former variable as base is sometimes constricted and at other times widened: beak reaches third coxæ: hairs as in stem mother. Length of body 1.96 mm. to 2.13 mm. Width (metathorax) .97 mm. to 1.07 mm. Cornicles .21 mm. to .24 mm. (average .23 mm.). Cauda .20 mm. Beak .53 mm. to .57 mm. Antennæ; III .33 mm. to .37 mm., IV .19 mm. to .23 mm., V .19 mm. to .21 mm., VI .07 mm. to .09 mm., filament of VI .33 mm. to .34 mm.

Taken during March, April and May, 1914 and 1915, in curled leaves.

Alate viviparous female (Fig. 16, 20–22). Apple green; head, thorax, antennæ, cornicles, apex of cauda, black or dark brown; legs yellowish-green; apical half to two-thirds of femora, tibiæ and tarsi, blackish; base of antennal III pale; transverse rows of dark brown spots occur on disk of abdomen and lateral spots are sometimes present: Antennæ longer than the body, their structure as in stem mother, III with from 29 to 35 tuberculate circular sensoria the whole length of joint, V and VI with usual apical sensoria; hairs numerous, about equal in length to the width of the joints: eyes dark red: beak reaches third coxæ: wings as in *Myzus;* stigma and insertions light green; first and second discoidals narrowly clouded; second fork of third discoidal nearer wing apex than first fork: legs rather long and narrow: cornicles as in stem mother but considerably longer and not thickened basally: cauda as in apterous forms: hairs of body are longer than in the apterous forms. Length of body about 1.60 mm. Width (mesothorax) .67 mm. to .69 mm. Cornicles .25 mm. to .27 mm. Cauda .20 mm. Beak .57 mm. Wing expanse 6.57 mm. to 6.66 mm. Antennæ; III .59 mm. to .66 mm., IV .33 mm. to .36 mm., V .30 mm. to .35 mm., VI .08 mm. to .10 mm., filament of VI .50 mm. to .57 mm.

Collected with apterous forms during March, April and May, 1914 and 1915.

Oviparous female (Fig. 16, 23–26). Pale whitish-yellow; eyes bright red; the dark markings of the viviparous forms appear very faintly on the dorsum of the body in the ovipara; coxæ, cornicles and cauda light grey; tarsi grey; joint VI of antennæ grey, rest pale: antennæ half the body in length; joint III with 3 to 4 circular sensoria on basal half; V and VI with usual sensoria; V slightly longer than IV; filament of VI longer than III; frontal tubercles as in other forms; hind tibia is dilated for its basal half and bears about 26 sensoria on this portion: cornicles and cauda as in alate

female but shorter. Length of body 1.64 mm. to 1.80 mm. Width (third abdominal segment) .83 mm. to .90 mm. Cornicles .20 mm. Cauda .15 mm. to .17 mm. Beak .40 mm. Antennæ; III .25 mm. to .26 mm., IV .13 mm. to .14 mm., V .14 mm. to .15 mm., VI .07 mm., filament of VI .26 mm. to .29 mm.

Collected in curled foliage May 7, 1914.

Male pupa. Brick red; wing-pads whitish. Taken May 7, 1914.

Male (Fig. 16, 27, 28). General color red; head, thorax, cornicles, cauda, sterna, black; antennæ black, base of III light red; legs pale yellowish-red, knees broadly, tarsi, apical half of tibiæ, black; stigma and insertions of wing light green; veins black, discoidals I and II narrowly clouded and thickened; eyes dark red: antennæ much longer than body, on obvious frontal tubercles; II obtusely toothed; filament of VI longer than III; IV longer than V; sensoriation III 40 to 44 circular tuberculate the whole length of joint, IV 10 to 12 dispersed throughout joint, V 8 to 14 (besides apical) disposed as on IV, VI 1 to 2 besides apical group: cornicles imbricated, cylindrical: cauda ensiform: beak reaches third coxæ, pale, apex dusky: legs long and narrow: abdomen red, with lateral brown spots and faint brown markings on disk: whole body clothed with hairs, of which there are several rows. Length of body 1.32 mm. to 1.54 mm. Width (mesothorax) .58 mm. to .60 mm. Cornicles .18 mm. to .19 mm. Cauda .16 mm. Expanse of wings 5.40 mm. Beak .49 mm. Antennæ; III .59 mm. to .64 mm., IV .30 mm. to .40 mm., V .27 mm. to .36 mm., VI .08 mm. to .11 mm., filament of VI .63 mm. to .68 mm.

Type: U. S. National Museum Catalogue, No. 20073.

Taken in curled foliage May 20, 1913, and May 7, 1914.

I have never located any winter eggs. The aphids are not to be found after the month of May and so I conclude that the winter eggs are deposited in this month and that they do not hatch until the spring following. The stem mothers must hatch as early as February as I have collected mature second generation individuals in the last week of March.

Explanation of Figure 16

1–3. *Vacuna dryophila* (?). 1: Alate viviparous (?) female, head and antennæ 2: Male. 3: Oviparous female, and last antennal joint (enlarged).

4–8. *Callipterinella annulata*. 4: Apterous viviparous female. 5: Apterous oviparous female, antenna. 6–8: Male. 6: antenna. 7: wing. 8: cornicle.

9–14. *Aphis neo-mexicana* var. *pacifica*. 9–11: Alate viviparous female. 9: antenna. 10: cornicle. 11: cauda. 12–14: Apterous viviparous female. 12: antenna. 13: cornicle. 14: cauda.

15–28. *Myzus ribifolii*. 15, 16: Stem mother. 15: antenna. 16: cornicle. 17–19: Apterous viviparous female. 17: head and antenna. 18: cornicle. 19: cauda. 20–22: Alate viviparous female. 20: antenna. 21: cornicle. 22: cauda. 23–26: Oviparous female. 23: antenna. 24: cornicle. 25: cauda. 26: hind tibia. 27, 28: Male. 27: antenna. 28: cornicle.

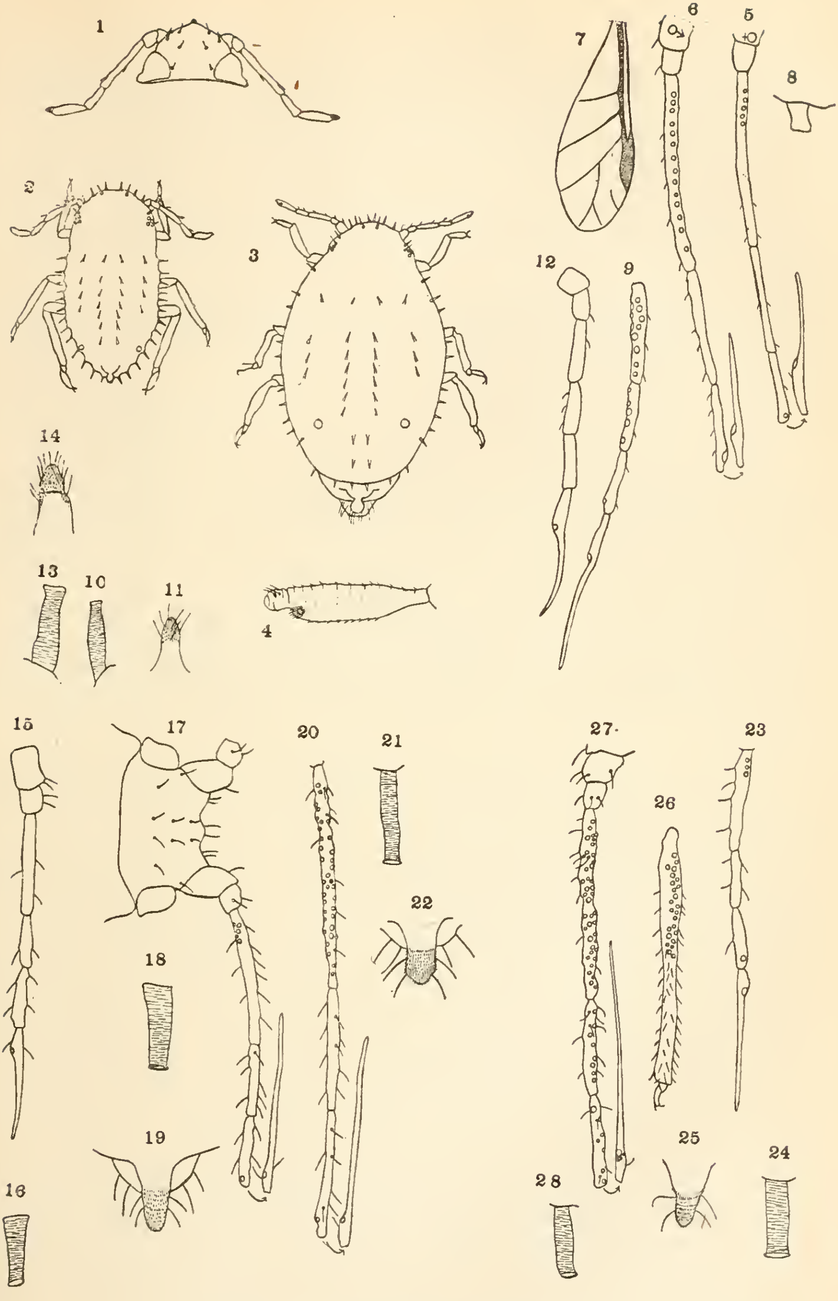

Fig. 16, see explanation on opposite page.

Scientific Notes

The Angoumois grain moth (*Sitotroga cerealella* Oliv.) is the subject of much complaint, especially in Pennsylvania, in York county, injury being chiefly to wheat.

Wanted: Specimens of Œstridæ. Dr. C. H. T. Townsend has under way a special study of the Œstrid flies. He is especially desirous of obtaining specimens of the larvæ of any species of *Cephenomyia* which, as is well known, are found more or less commonly in the nasal passages of deer. It is requested that the Bureau agents obtain specimens of these larvæ either themselves or through friends for Dr. Townsend's work.

An Illustration of the Importance of Quarantine against Injurious Insects. Early in 1914, Mr. E. C. Green, an American engaged in the encouragement of cotton culture by the Brazilian government, made a careful survey of the cotton belt of Brazil. He was looking especially for the boll weevil and the pink bollworm. Neither insect was found in the course of considerable travel and extensive examinations of seed. Late in 1916 Mr. Green made another trip over the same territory and found that the pink bollworm was generally and thoroughly established. The way in which the insect was introduced is clear: In 1913 the Brazilian government agitated the cultivation of Egyptian cotton in that country. An agent was sent to Egypt and large quantities of seed were shipped to Brazil. No precautions were taken as to the seed obtained, and it was all admitted to Brazil without fumigation or other treatment. The Brazilian goverment has inspectors located in every state capital. The seed was distributed to these inspectors and in turn by them to local representatives. This was probably as thorough a method of desseminating an insect as is possible. The Brazilian government now realizes what has been done and various senators seriously consider an enactment requiring the burning of all the cotton fields in the Republic.

Monthly Letter, Bureau of Entomology, February, 1917.

Controlling the Cottony Cushion Scale in New Orleans. The November *Monthly Letter* of the Bureau of Entomology gives a short account of a citizens' meeting at Tulane University in New Orleans to consider a campaign against the cottony cushion scale. The committee appointed by the president of the Academy of Sciences, under whose auspices the meeting was called, presented the matter to Mayor Behrman of New Orleans, Director Dodson of the Experiment Stations, and Mr. Alexander, in charge of the State Conservation Commission, and urged sufficient appropriations for a campaign in rearing and distributing the Australian lady beetle, *Novius cardinalis.* The result was that the city commission agreed to contribute $2,500 in cash and move a greenhouse from a property recently purchased to a convenient situation for the winter rearing of the lady beetles. Professor Dodson, for the Experiment Stations, contributed $500 and an equal amount was obtained from the Conservation Commission, while the State Government appropriated $2,500, making available the total sum of $6,000. The greenhouse has now been erected at the Sugar Experiment Station in Audubon Park; which seemed the most suitable place for the work. The rearing of the lady beetles was begun last summer by Mr. E. R. Barber, and is still in his hands, an appeal having been made for an expert by Mayor Behrman to Doctor Howard and Secretary Houston. Specimens of *Novius* have been obtained from Mr. Harry S. Smith in California and Mr. A. C. Mason in Florida, as well as scales infested with *Cryptochætum* (*Lestophonus*) *monophlebi* from Mr. Smith. Several colonies of lady beetles have been started, and with the aid of the greenhouse many thousands should be obtained in the near future.

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Our country has entered a gigantic struggle in which material assets of many kinds play a most important part. There is urgent need for the conservation and development of all resources—life, health, food—to designate a few having a close relation to applied entomology. An army or navy can accomplish little without the foregoing essentials. There are many openings for the economic entomologist to demonstrate the utility of his calling. The urgent need of better camp sanitation, so far as insects are concerned, warrants an entomological staff attached to every large camp and hospital center and associated with the medical or sanitary corps in handling insect problems, particularly flies and other disease carriers, though body parasites and animal pests should not be ignored. These men should have a rank which would give weight to their recommendations, resources which would permit intensive studies of the entire problem if necessary, and facilities for the practical application of results to field and camp conditions. The work in the various localities should be coördinated and directed by a supervising entomologist in order to ensure the greatest efficiency.

It falls to the economic entomologist more than anyone else to advise and urge the adoption of measures which will minimize the effect of insect ravages, especially upon staple crops. Dr. Howard, of the Bureau of Entomology, is organizing his forces to bring before the country at large information of immediate value in insect control, and now seeks the coöperation of American entomologists on reporting unusual insect outbreaks. Observers in the southern portions of the country

can render material aid in reporting the abundance of pests, especially those likely to be injurious a little farther north. Warnings of this nature, particularly if distributed to entomologists who could investigate local conditions and appraise possibilities, would be of immense service in preventing extensive injuries. The staple crops should receive special attention in a serious effort to forecast, and so far as possible forestall, insect depredations. The economic entomologist is called upon all too frequently after the remedial stage has passed. Here is an opportunity, which may not come again for a generation or more, to make more general a system of intelligent prognosis which would result in adoption of preventive rather than remedial measures.

Reviews

Guide to the Insects of Connecticut, Part III. The Hymenoptera or Wasp-Like Insects of Connecticut. By H. L. Viereck and others. Bulletin 22, State Geological and Natural History Survey. (George S. Godard, State Librarian, Hartford, Conn. $2.00.)

This work of 824 pages and 10 plates is the only general presentation of the Hymenoptera as a group, which has appeared for many years in this country, and though restricted to a single state will nevertheless be of wide application, as in Connecticut the Transition and Upper Austral areas both occur.

Prepared by Mr. H. L. Viereck with the collaboration of such entomologists as A. D. MacGillivray, C. T. Brues, W. M. Wheeler and S. A. Rohwer, the work represents all the recent progress in our systematic knowledge of this order, in fact to a somewhat discouraging degree for those who look for the genera Pimpla, Bombus and many of the other old "standbys" in vain. Progress in this line, however, must probably be through a seemingly chaotic period, and the sooner this comes and has been traversed, the better.

Keys from the superfamilies all the way to the species are provided, together with data as to dates and places of capture in the state, food or host, and occasionally other items are given. In addition, species not as yet actually taken in the state but probably present there are included. New species are described, making the book not only a list and key but a necessary place of reference for original descriptions, some of which, unfortunately, are extremely brief.

Minor errors are too numerous in the book, and to distinguish half a dozen species in an analytical key by differences in length of body of one millimeter in a total length of from eight to twenty millimeters is at least doubtful, but the value of the book as a whole is such that many errors can easily be forgiven, bearing in mind the amount of ground it was necessary to cover. The plates are excellent in their way. (*Advt.*).

H. T. F.

Current Notes

Conducted by the Associate Editor

Mr. Emery A. Proctor, Gipsy and Brown-Tail Moth Investigations, Bureau of Entomology, died December 11, 1916.

According to *Science*, Dr. B. R. Poppius, the Finnish entomologist, died November 27, 1916, at the age of forty years.

Dr. L. O. Howard gave a lecture, February 1, before the Washington Academy of Sciences, on "The Carriage of Disease by Insects."

Mr. C. O. Waterhouse, for many years assistant keeper of the British Museum, died on February 4, at the age of seventy-three years.

Recent resignations from the Bureau of Entomology are as follows: Oswald D. Ingall and Charles F. Guptill, Gipsy and Brown-Tail Moth Investigations.

Professor W. C. O'Kane, Durham, N. H., attended the annual meeting of the New England Nurserymen's Association at Hotel Taft, New Haven, Conn., January 30–31.

Dr. Edith M. Patch, entomologist, Maine Agricultural Experiment Station, Orono, Me.; Prof. George A. Dean, state entomologist, Manhattan, Kan.; Prof. Georges Maheu, provincial entomologist, Quebec, Can., visited the Bureau of Entomology during February.

During the month of January the following were visitors at the Bureau of Entomology: C. Gordon Hewitt, Ottawa, Can.; G. A. Dean, Manhattan, Kan.; E. D Ball, Madison, Wis.; and Prof. James G. Sanders, Harrisburg, Pa.

According to *Science*, the governor of Minnesota has recommended to the legislature that $25,000 be appropriated for the use of the state entomologist in combating the white-pine blister rust in Minnesota.

Dr. Alvah H. Peterson, whose New Jersey appointment was noted in the February issue of the Journal, is assistant entomologist of the New Jersey Agricultural College Experiment Station, and instructor in Entomology in Rutgers College.

Mr. P. B. Wiltberger has been appointed instructor in entomology at the Michigan Agricultural College and assistant entomologist of the Station *vice* G. C. Woodin resigned, the appointment to take effect April 1.

Recent appointments to the Bureau of Entomology are as follows: Carl F. W. Muesbeck, scientific assistant, Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass; J. E. Graf, Truck Crop and Stored Product Insect Investigations, Plant City, Fla.

Dr. Marcus T. Smulyan, formerly connected with the Virginia Agricultural Experiment Station, has been appointed to the position of Specialist in Insects and Carriers of Insect Diseases, Bureau of Entomology, and assigned to duty at the Gipsy Moth Laboratory, Melrose Highlands, Mass.

The offices of the Gipsy and Brown-Tail Moth Investigations, Bureau of Entomology, were moved in December from 43 Tremont Street, Boston, to 964 Main Street,

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Melrose Highlands, near the laboratory. The Inspection and Quarantine Service still continues its office at the Boston address.

Professor W. C. O'Kane, Durham, N. H., recently published a new book, entitled, "Jim and Peggy at Meadowbrook Farm." Its purpose is to convey to city children a picture of everyday farm life; it is profusely illustrated with New Hampshire scenes, and is published by the Macmillan Company.

Mr. Edmund Baynes Reed, one of the pioneer entomologists of Canada, died at Victoria, B. C., November 18, 1916, in the seventy-ninth year of his age. Mr. Reed was interested in both systematic and economic entomology, and was one of the original members of the Entomological Society of Ontario when it started in 1863.

Dr. E. F. Phillips, Bureau of Entomology, attended the following meetings during the months of January and February: Kentucky State Beekeepers' Association, Lexington, Ky., January 4; North Carolina Beekeepers' Association, Winston-Salem, N. C., January 11; Colorado Beekeepers' Association, Fort Collins, Col., January 18 and 19; National Beekeepers' Association, Madison, Wis., February 6–8.

The following transfers have been made in the Bureau of Entomology: D. A. H. McCray, from Bee Culture to Insects Affecting the Health of Man, to be established at New Orleans, La.; T. C. Barber, from Southern Field Crop Investigations to the Federal Horticultural Board, to be stationed at San Antonio, Tex.; W. H. Larrimer, Charleston, Mo., to West Lafayette, Ind.; Julian J. Culver, Gipsy Moth Laboratory, to Deciduous Fruit Insect Investigations, stationed at Fort Valley, Ga.

Dr. L. O. Howard left Washington on the fifth of February, and visited the field station at Orlando, studying with Mr. W. W. Yothers the effects of the freeze of February 3 on the orange crop and the orange trees and on the insects of the orange. He also consulted with Mr. J. E. Graf, who has established a station at Plant City; and later visited Thomasville, Ga., where Mr. George D. Smith is studying cotton insects, stopping at Atlanta on his return to Washington for consultation with Mr. E. L. Worsham concerning coöperative work in Georgia.

The completion of the Carnegie Institution "Monograph of the Mosquitoes of North and Central America and the West Indies" is in sight! The final proofs, including the index to the last volume, have been read, and the Institution believes that the final volume will be ready for distribution about April 15. It is of interest to note that the indices to Volumes 3 and 4 are combined in Volume 4, Volume 3 carrying no index. The pagination of Volumes 3 and 4 is continuous.

The Federal Horticultural Board has had a thorough survey made by its California collaborators, under the direction of Mr. Maskew, of the department's introduction gardens at Chico, Cal. This survey is an annual function and precedes the shipment of plant material from this garden. A similar survey is in progress in relation to the introduction gardens in Florida, notably the garden at Miami, and involves inspection of plants both for insect pests and fungous diseases. Various entomological and pathological experts of the Board, including members of the Board, were in attendance during the month of January at important conferences in New York over quarantine matters, particularly in relation to the blister rust, in connection with the entomological and pathological meetings held in that city, and with the International Forestry Congress held at Washington. At the latter Congress the chairman of the Board presented an address on the subject of losses occasioned by introduced insect pests and plant diseases. As a result of these conferences and of the needs of the plant quarantine service, an effort will be made to amend the Plant Quarantine Act, broad-

ening its powers in relation to domestic quarantines so that introduced pests of a fairly widespread character, like the blister rust and the alfalfa weevil, can be more effectively controlled.

Professor Raymond C. Osburn of the Connecticut College for Women, New London, Connecticut, has been elected head of the Department of Zoölogy and Entomology of the Ohio State University, his appointment to take effect July 1. He will assume the duties carried during the last nineteen years by Dr. Herbert Osborn, who was last year elected Research Professor and who will hereafter give his entire time to research work, including the direction of research work by graduate students, and, for the present, the directorship of the Lake Laboratory and of the Ohio Biological Survey. Dr. Osburn graduated from the Ohio State University in 1898, received the master's degree from the same institution in 1900 and the Ph. D. degree from Columbia in 1906. He has been connected as a teacher with the Starling Medical College, Columbus, Ohio; Fargo College, Fargo, N. D.; Clinton High School of Commerce, New York City; Barnard College, Columbia University, and the Connecticut College for Women, in which he is now Professor of Biology. He is perhaps best known to entomologists as the author of a number of papers on Syrphidæ and Odonata and as recently President of the New York Entomological Society. While his own investigations may deal largely with other forms, especially aquatic groups of invertebrates and fishes, entomologists may feel assured that he will give full support to the entomological work and especially to the lines of applied entomology which have been a prominent part of the work in the Ohio institution.

The Third Annual Meeting of Entomological Workers of Ohio was held at Ohio State University on February 2, 1917, with thirty members in attendance. The program consisted of reviews of projects and reports on investigations of members of the Ohio Experiment Station, the State Division of Orchard and Nursery Inspection, and the Department of Entomology of the University. The following program was presented:

Distribution of Ohio Broods of Periodical Cicada with Reference to Soil. H. A. Gossard.

General Reports from Heads of Department Organizations: H. A. Gossard, Ohio Experiment Station; N. E. Shaw, State Division of Orchard and Nursery Inspection; Herbert Osborn, Department of Zoölogy and Entomology, Ohio State University; H. A. Gossard, Review of Projects; J. S. Houser, Review of Projects; W. H. Goodwin, Review of Projects; R. D. Whitmarsh, Review of Projects; D. C. Mote, Review of Projects; J. L. King, Review of Projects; Richard Faxon, Nursery Imports; F. D. Heckathorn, Winter Work in Nurseries and Surroundings; H. E. Evans, An Inspector's Itinerary for a Year; H. J. Speaker, Report of Control of Gipsy Moth Outbreak; C. L. Metcalf, Predaceous Insects; C. J. Drake, Notes on Aquatic and Semi-Aquatic Hemiptera of Ohio; Herbert Osborn, Problems with Meadow Insects; T. L. Guyton, Aphididæ of Ohio.

A permanent organization was effected and the following officers elected for 1917–18: N. E. Shaw, Chairman; J. S. Houser, Secretary.

A special appropriation of $50,000 has been requested in relation to the possible invasion of Texas by the pink bollworm, this money to be expended by the Federal Horticultural Board in coöperation with the Bureau of Entomology in quarantine border control, and control in Texas in particular relation to the various cotton mills which have received considerable quantities of seed from Mexico for milling purposes during the year. T. C. Barber has been transferred from the branch of Southern Field Crop Insect Investigations to the Federal Horticultural Board and was placed

in field charge of this work, effective February 1. An inspection service will be organized, consisting of at least four persons, two of whom will be assigned at once to border control work, and the other two to act in conjunction with Mr. Barber in the interior service and control. The continued disturbed condition in Mexico has frustrated the attempt to make a direct survey of the infested region in Mexico, and the negotiations for permission to make and safeguard such survey, conducted through the Mexican Ambassador Designate and the State Department have so far been unsuccessful.

Mr. John F. Strauss, connected with the Bureau of Entomology since 1903, died on Tuesday, January 2, 1917, at the Pottenger Sanatorium, Monrovia, Cal. After leaving the public schools, Mr. Strauss spent one year in the Kansas State Agricultural College, came East and entered the Virginia State Agricultural College, where he completed a four years' course in Agriculture, receiving the degree of Bachelor of Science. After graduation he took up the study of medicine, spending two years at the University of Virginia, completing the courses in comparative anatomy, histology, and bacteriology. He did not further pursue his medical studies, but returned to the Virginia Polytechnic Institute in the fall of 1897, pursuing graduate work and receiving the degree of Master of Science. Subsequently Mr. Strauss was connected with the Virginia Experiment Station and College as laboratory assistant and assistant instructor. Upon entering the Bureau, Mr. Strauss was employed as an entomological draftsman in the branch of forest entomology, working under the direction of Dr. A. D. Hopkins. During his period of service in that branch from 1903–1908, he made many excellent illustrations of forest insects, among which are those illustrating articles on "Insect Injuries to Forest Products" in the Yearbook for 1904, and "Insect Enemies of Forest Reproduction" in the Yearbook for 1905, and "Injuries to Forest Trees by Flathead Borers" in the Yearbook for 1909. After a short assignment as insect artist to the Bureau in general, during which time he prepared illustrations of cotton insects at the Dallas (Texas) laboratory, and illustrations of parasites of the gipsy and brown-tail moths at the Melrose Highlands (Mass.) laboratory, he was transferred to the office of Deciduous Fruit Investigations, with which office he was connected at the time of his death. Mr. Strauss accomplished a large amount of work in the preparation of drawings of deciduous fruit and other insects, illustrating most of the publications that have appeared from that branch since about 1910. Two papers have been published by Mr. Strauss, namely, one on *Clinocoris lectularius* and the other on the grape leaf-folder, *Desmia funeralis*. He was a member of the Entomological Society of Washington. Mr. Strauss possessed a high degree of artistic ability which, combined with his entomological training, made him unusually successful in insect delineation work. He was earnest and thorough, and possessed a personality which endeared him to all who came to know him.—*Monthly Letter* of the Bureau of Entomology.

Solenopsis Interferes with Rearing Experiments in Texas. Mr. D. C. Parman, Bureau of Entomology, writes that he is having very serious trouble with *Solenopsis*. This ant has been a serious obstacle in the way of the rearing experiments at Uvalde, Texas, but according to his reports it is much worse this year than ever before. He says that there is a large bed heavily infested and that tunnels have been traced as far as 150 yards in some directions. I am wondering if any one in the Bureau has had any experience in the control of this ant under such conditions and if so should like to have their experience.

F. C. Bishopp.

Mailed April 17, 1917.

JOURNAL

OF

ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN
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CURRENT NOTES AND NEWS should be sent to the Associate Editor, W. E. Britton, Agricultural Experiment Station, New Haven, Conn.

SUBSCRIPTIONS AND ADVERTISEMENTS may be sent to the Business Manager, A. F. Burgess, Melrose Highlands, Mass.

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CONTENTS

[1] Withdrawn for publication elsewhere.

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VOL. 10 JUNE, 1917 No. 3

Proceedings of the Second Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

The second annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held at Stanford University, California, April 5 to 6, 1917. The business was transacted at the first and last meetings, but in the proceedings are all included in the first part.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by Chairman A. W. Morrill at 10.30 a. m., Thursday, April 5, 1917. There were 37 members and visitors present. Of this number the following were members:

Burke, H. E., Los Gatos, Cal.
Coleman, G. A., Berkeley, Cal.
Davidson, W. M., Sacramento, Cal.
Doane, R. W., Stanford University, Cal.
Essig, E. O., Berkeley, Cal.
Foster, S. W., San Francisco, Cal.
Herms, W. B., Berkeley, Cal.
Morrill, A. W., Phoenix, Ariz.
Morris, Earl, San Jose, Cal.
Van Dyke, E. C., Berkeley, Cal.

CHAIRMAN A. W. MORRILL: The meeting will please come to order. May we first have the report of the secretary-treasurer:

REPORT OF TREASURER

EXPENSES SINCE LAST MEETING

Feb. 5, 1917
Affiliation fee to Pacific Division, American Association for the Advancement of Science $5.00

April 2, 1917

Expenses for Stanford meeting:	
Stamped envelopes, 1 c. legal size	$0.80
Multigraphing circular letter	1.25
Printing 150 copies application for membership	2.75
Total	$9.80

Examined and found correct.

R. W. Doane,
H. E. Burke,
Auditors.

Chairman A. W. Morrill: There are a number of committees to be appointed as follows:

Resolutions Committee

H. J. Quayle G. P. Weldon
E. O. Essig

Membership Committee

H. S. Smith........1 year
H. J. Quayle........2 years
H. E. Burke........3 years

Auditing Committee

H. E. Burke R. W. Doane

Nominating Committee

H. E. Burke R. W. Doane

The last part of the business meeting was called by Chairman A. W. Morrill, Friday, April 6, 4.30 p. m.

Chairman A. W. Morrill: At the urgent request of A. L. Barrows, Secretary of the Pacific Division of the American Association for the Advancement of Science, for the appointment of a delegate to act on the affiliation committee, especially to consider means of assistance in the national crisis, which is to meet at 5 p. m., R. W. Doane has been appointed to serve for the ensuing year.

It was proposed by the secretary that other entomological societies of the Pacific Slope be invited to participate in the meetings of the Pacific Slope Branch in the future. Such meetings would be of mutual benefit and would have a tendency to stimulate work in all. This proposal was made in the form of a motion by H. E. Burke and seconded by R. W. Doane. Carried by the house.

Chairman A. W. Morrill: We will now have the report of the nominating committee:

REPORT OF THE NOMINATING COMMITTEE

For chairman...G. P. Weldon
For vice-chairman...H. J. Quayle
For secretary-treasurer..E. O. Essig

H. E. Burke,
R. W. Doane,
Nominating Committee.

REPORT OF THE MEMBERSHIP COMMITTEE

The membership committee approved of the following applications for membership with the recommendation that they be submitted to the regular membership committee of the association for final action:

Day, L. H., Hollister, Cal.
Ferris, G. F., Stanford University, Cal.
Freeborn, Stanley B., Berkeley, Cal.
Gray, Geo. P., Berkeley, Cal.
Henderson, W. W., Logan, Utah.
Penny, Donald D., Berkeley, Cal.
Severin, Henry H. P., Berkeley, Cal.
Vickery, R. K., Saratoga, Cal.
Wells, R. W., Bozeman, Mont.
Woodworth, H. E., Berkeley, Cal.
Herbert, F. B., Los Gatos, Cal.

By vote of the house the report of the nominating committee was accepted and the secretary instructed to cast the ballot for the election of the officers named.

The report of the membership committee was accepted with the instructions that the applications be referred to the general committee as proposed.

Upon motion of the house the meeting was adjourned.

E. O. Essig,
Secretary.

PART II. PAPERS AND DISCUSSIONS

It was impossible to report the discussions following the papers as no official reporter was secured for this purpose and rather than give a partial account, this part of the meetings has been omitted.

Chairman A. W. Morrill: The first paper on the program is one prepared by myself and is as follows:

COTTON PESTS IN THE ARID AND SEMI-ARID SOUTHWEST

By A. W. Morrill, *Phoenix, Arizona*

During the past few years there has been a notable increase in cotton production in the arid and semi-arid Southwest. This increase is of interest inasmuch as it has tended to offset the losses morf the Mexican boll weevil in the humid region of the cotton belt. It is of further interest since in Arizona and to a small extent also

in California, a kind of cotton, Egyptian, is being produced for which other sections of the country are not adapted and for which there will be an increasing demand as the Mexican boll weevil damage to the Sea Island cotton industry in the East increases.

The growth of the cotton industry in west Texas is shown by a comparison of a series of recent years with an earlier series. For the seasons of 1899, 1900, 1901 and 1902 the west Texas counties lying west of the ninety-eighth meridian, produced on the average 17 per cent of the total crop of the state whereas for the seasons 1911, 1912, 1913 and 1914 the same section produced on the average about 27 per cent of the state's crop.

In the extreme arid portion of the southwestern United States cotton has become firmly established as an important crop within the short space of seven years. In 1909 the total cotton production of the states of California, Arizona and New Mexico amounted to only 390 bales whereas in 1916 the production had reached a total of over 52,000 bales in these states. The New Mexico acreage is virtually an extension of the west Texas or semi-arid cotton-growing region and is of not as much interest as presenting new problems in economic entomology as are cotton-growing districts of Arizona and California. These are located in the most arid section of the United States where the annual rainfall averages less than eight inches. With its important relation to the dairy and beef feeding industries, cotton growing has become one of the corner-stones of agriculture in this part of the arid Southwest. Its direct returns to this region amounted to about six million dollars for the past season and it is expected that it will become a twenty million dollar industry within a few years.

The development of this new industry as briefly outlined has developed also the need for special protection against the introduction of pests and for a practical knowledge of other cotton pests which already exist in the arid Southwest. The existence in parts of southern Arizona of a native species of wild cotton plant (*Thurberia thespesiodes*) with its native insect enemies introduces an element of possible danger and a factor which is highly interesting from the scientific standpoint.

Cotton growing in the arid and semi-arid Southwest is confined to the Lower Sonoran area of the Lower Austral life zone and to the Tropical region on the lower Colorado. Passing westward from the ninety-eighth meridian in Texas, a marked difference in the pests of cotton is soon noted. Certain ones are found in abundance which do not occur or are rarely found in the humid region, others commonly found in both regions become more injurious to cotton and still others become less so. Further differences are noted between different localities just as local differences occur in the humid cotton belt.

In this paper no attempt is made to name all of the different species of insects which have been found on cotton or in cotton fields. There are dozens of insects, especially among the Hemiptera, which are commonly found on the cotton plant and which are recognized as capable of becoming injurious but which are not known to have done noticeable damage to cotton so far. In the future some of these species will increase injuriously from time to time, usually in restricted localities, while others which have already demonstrated their injuriousness will from time to time become temporarily of little or no consequence as cotton pests.

Hemiptera

Up to the present time the insect order Hemiptera has provided the largest number of the more destructive cotton pests found through the section under consideration and in Arizona and California, at least, these insects promise to become the most troublesome group judged from their combined capacity for damage to cotton.

In west Texas the conchuela (*Chlorochroa ligata*) (12 and 13) is the most prominent plant bug having a history as a cotton pest. This insect has been taken at various points in southern Arizona. It was found feeding on the bolls of Thurberia in the Santa Rita Mountains but so far as known has not been taken on cultivated cotton in Arizona or California. It occurs in the Salt River Valley, a single specimen having been taken near Mesa on alfalfa.

The brown cotton bug (*Euschistus servus*) of the humid cotton-growing states (13) is represented in Arizona cotton fields by one of the same genus (*E. impictiventris*) which up to this time has proven to be our most common pentatomid cotton pest. This has been of common occurrence on cotton in the Salt River Valley and in the lower Colorado Valley near Yuma but like its eastern relative its injuriousness is due to its general occurrence in small numbers in almost all cotton fields rather than to fluctuating abundance and occasionally severe outbreaks.

The Arizona cotton stainer (*Dysdercus albidiventris*) has been the cause of the most severe local insect injury to cotton so far observed in the Salt River Valley (17). It has also been found on cotton in the Gila Valley near Sacaton but has not been reported from the cotton-growing district of southwestern Arizona and southeastern California. Another Pyrrhocorid bug, *Euryopthalmus* (=*Largus*) *succinctus*, is common and widely distributed in the arid Southwest but there is only one record of its occurring on cotton in sufficient numbers to do noticeable injury. This observation (13) was made in western Texas. In the extreme arid Southwest it has been taken on cotton near Bard, California; Florence, Arizona; and Mesa, Arizona.

The western leaf-footed plant bug (*Leptoglossus zonatus*) which has been noted as an enemy of cotton in northern Mexico (13) is very abundant in parts of southern Arizona and has been taken on cotton in the Salt River Valley and at Bard, California. Its favorite food is the fruit of the pomegranate but it should be regarded as a cotton pest owing to its known capability for damaging the bolls and occasional injury to cotton may be expected from this species, as is done in the humid cotton sections by its eastern relatives (*L. phyllopus* and *L. oppositus*).

The tarnished plant bug (*Lygus pratensis* and its varieties)[1] was observed by Mr. W. D. Pierce of the Bureau of Entomology as injurious to cotton squares in the Imperial Valley in California in 1913 and the same species has since proven quite destructive locally (16) in the Salt River Valley in Arizona. Although this insect occurs throughout the eastern cotton belt it does not appear to have attracted attention as a cotton pest except in Arizona and California.

Orthoptera

Four or five species of Orthoptera have placed this insect order ahead of the Lepidoptera and of about equal grade with the Hemiptera in the total amount of damage to cotton in the arid Southwest. The most generally destructive species is the differential grasshopper (*Melanoplus differentialis*) well known also as a cotton pest in the humid sections (15). In the Salt River Valley ranking next to the differential grasshopper are two species of the genus Schistocerca (*S. vega* and *S. shoshone*) which are common in cotton fields and in one locality in 1913 proved exceedingly destructive (14). During 1916 a species of cricket was one of the most destructive cotton pests in the Imperial Valley, necessitating the replanting of several hundred acres, according to Mr. E. A. McGregor of the U. S. Bureau of Entomology, who, in connection with his cotton insect investigations, is giving special attention to this pest. Grasshoppers are also reported as among the leading Imperial Valley cotton pests.

Lepidoptera

The arid Southwest has an extremely formidable list of lepidopterous enemies of cotton, although the combined damage so far has not been very extensive. This list includes the cotton bollworm

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[1]The late O. Heidemann identified several lots of this material as "*Lygus pratensis*," "*Lygus pratensis* var. *lineolarius*," "*Lygus pratensis* var." and "*Lygus* sp. near *pratensis*." Evidently *Lygus pratensis* is a variable species and it will require special study to properly distinguish the southwestern forms as subspecies or to prove that they are merely color varieties.

(*Heliothis obsoleta*), the cotton leafworm (*Alabama argillacea*), the salt marsh caterpillar (*Estigmene acræa*), the cotton boll cutworm (*Prodenia ornithogalli*), the fall webworm (*Hyphantria cunea*), the western army cutworm (*Chorizagrotis agrestis*) the cotton leaf perforator (*Bucculatrix thurberiella*) and an undetermined bollworm which attacks the bolls of the Arizona wild cotton.

In their consideration of the distribution and destructiveness of the cotton bollworm in relation to life zones, Quaintance and Brues (21) say: "In Texas, from about the ninety-eighth meridian westward, the bollworm rapidly becomes of less and less importance along with the diminishing rainfall." In Arizona and California cotton-growing districts the bollworm attacks corn as extensively as it does in the humid eastern cotton states but for some as yet unexplained reason the insect has thus far done very little damage to cotton in these sections. It is noteworthy, however, that in the arid Laguna district in Mexico, about 500 miles south of Phoenix at an elevation of 3,700 feet, the cotton bollworm has during certain seasons caused heavy losses.

The cotton leafworm was found on Thurberia plants in the mountain canyons of southeastern Arizona, and on cultivated cotton in the Salt River Valley and near Tucson in the summer of 1913. The next season it was found in Graham County in eastern Arizona where cotton was being tried out on a small scale about 75 miles from any other plantings. The insect has not been found near Yuma although carefully searched for and Mr. McGregor of the U. S. Bureau of Entomology informs me that he failed to find a single specimen of the leafworm in the Imperial Valley in 1916. In one instance the writer observed a Salt River Valley Egyptian cotton field partially defoliated by the leafworm but this was late in the season and apparently no material damage was done to the crop.

The salt marsh caterpillar is a common pest in Salt River Valley cotton fields but there is no record of its injury to cotton elsewhere in the arid Southwest. The injury from this insect is sporadic and the occasional local outbreaks which have been noted have apparently been due to the insects having completely consumed the supply of a preferred food plant, a common weed known as the yellow-flowered ground cherry (*Physalis angulata* var. *linkiana*).

The cotton boll cutworm and the fall webworm can only be recorded as among those cotton pests present in Salt River Valley fields. The actual damage noted in any case has been inappreciable.

Cutworms did considerable damage in the spring of 1916 in one locality in the Salt River Valley, necessitating the replanting of several acres where the use of poisoned bran was not resorted to in time. Attempts to breed out the insects were unsuccessful but it is be-

lieved that all specimens of the worms found were "western army cutworms."

The cotton leaf perforator is a cotton pest which is evidently native of the arid Southwest. It was originally found on the Arizona wild cotton but has since appeared on cultivated cotton in the Salt River Valley (15) and the Imperial Valley (11), strongly indicating that the insect has other native food plants than the Thurberia. If, however, the Arizona wild cotton is the insect's only native food plant and the Salt River Valley infestation is traceable to this source, the insect may have been carried to the Imperial Valley by means of cotton seed shipments. Owing to the activity of parasites this insect is not considered a very serious cotton pest although in 1914 it was very abundant in the Salt River Valley and in 1916 in the Imperial Valley.

The unidentified Thurberia or wild cotton bollworm is considered by the writer to be more widespread and destructive to its food plant than is the wild cotton weevil. The full grown larva is robust and about an inch in length and the adult is therefore a moth which we may presume to be fairly capable as a flier.[1] It is to be expected that this insect will be found in the cotton fields of the Casa Grande or Salt River Valley in Arizona within a few years. In captivity the worms feed as readily on Egyptian cotton bolls and squares as upon the Thurberia cotton and the importance of the insect as a pest will depend on its adaptability to conditions in irrigated cotton fields at elevations much lower than their present known limits.

Coleoptera

While the Mexican cotton boll weevil (*Anthonomus grandis*) has made some progress into the western section of Texas it has not thus far been able to fully adapt itself to semiarid conditions (8, 9, 10, 18). This does not in the writer's opinion preclude the possibility of this insect quickly adapting itself and proving injurious if introduced into the extreme arid sections where cotton is grown entirely under irrigation.

The Thurberia or Arizona wild cotton (*A. grandis thurberiæ*) weevil which is found only in and near certain mountain ranges in southeastern Arizona is properly regarded with apprehension. It is a form of the cotton boll weevil which is thoroughly adapted to arid conditions but at present it is harmless, and may remain so indefinitely. In the event that it appears at any time in the future in the cotton fields of the Casa Grande Valley—a new district where cotton will be grown

[1]Attempts to rear the adult have so far been unsuccessful. Dr. H. G. Dyar, who examined specimens of the larvæ, noted that they resembled those of *Sacadodes pyralis*, a worm which attacks cotton bolls in Trinidad.

this season, located about fifty miles from the insects' present range—the suspension of cotton growing in the district for one season would offer a practical means of complete eradication. The Arizona cotton fields have been closely inspected in the past in order that this and other cotton pests may be promptly detected in the event of their introduction. Proportionally more attention will be given to the new cotton district mentioned which lies between the Salt River Valley and the Santa Catalina Mountains. Even with its proximity to the cotton fields of Arizona, the wild cotton weevil is insignificant in comparison with the pink bollworm as a menace to the cotton industry of the arid Southwest. This latter pest will be mentioned again. The relation of elevation to the future distribution of the weevil in the arid Southwest is an interesting subject for conjectures but not a safe matter to investigate. The insect has been found at elevations from about 2,750 to 7,000 feet but is reported by Coad (3) as more abundant on plants growing at elevations from 3,500 to 5,000 feet. The cotton plantings in the Casa Grande Valley are all below 1,500 feet elevation and in the Salt River Valley below 1,300 feet. The discontinuance of cotton growing near Tucson, permanently it is hoped, has removed the most important element of danger, which consisted practically of an intermediate step between the present habitat of the weevil and the important cotton-growing districts of lower elevations.

Homoptera

The cotton aphis (*Aphis gossypii*) is the only representative of the Homoptera which has so far proven injurious to cotton in the arid Southwest. In the season of 1914 this insect, known in the older cotton states as a cotton pest only on account of occasional injury to very young plants, was notably destructive to cotton throughout the greater part of the growing season in the Yuma and Imperial Valleys (15). While no appreciable injury has so far been reported it is interesting to note that adults of a species of the insect family Aleurodidæ were observed on cotton in the Imperial Valley by Mr. W. D. Pierce in 1913 and a similar observation was made by Mr. Pierce and the writer in the Salt River Valley. The possibility of white flies becoming injurious to cotton occasionally is shown by a statement from Mr. E. A. McGregor of the U. S. Bureau of Entomology, located in the Imperial Valley in cotton insect investigations, who writes concerning them: "They frequently rise in clouds as one brushes through the rows." In the humid cotton belt we have a record by Ashmead of similar abundance of an Aleyrodid (*Asterochiton abutiloneus*) in Mississippi with but slight injury.

Thysanoptera

The only notable injury to cotton in the United States by insects of the order Thysanoptera is that by a western species, the bean thrips (*Heliothrips fasciatus*) in the Imperial Valley (7 and 20). This species occurs in the Salt River and Yuma Valleys and has been noted as injuring beans in the former section but so far has not been found on cotton in Arizona in injurious numbers. However, temporary injury to a few young cotton plants by another species (*Microthrips piercei*) was once noted in the Salt River Valley (14).

Acarina

Two species of mites occur in Arizona which are of interest in a consideration of cotton pests. The common two-spotted mite (*Tetranychus bimaculatus*) is a pest of violets and sometimes of strawberries in the Salt River Valley but there is no record of its occurrence on cotton anywhere in the arid Southwest. From the fact that hot dry weather is favorable for this pest in the East we must regard it as dangerous in its possibilities as a pest of cotton. The second representative of the Acarina referred to above is the wild cotton blister mite (*Eriophyes thurberiæ* Bks.) which is quite destructive to the Thurberia plant and would be an undesirable addition to our list of pests of cultivated cotton if it were to spread from its present habitat. This, so far as known, is limited to certain mountain canyons in southern Arizona.

In a general consideration of cotton pests a more or less arbitrary standard must be set in deciding what species are worthy of mention. As has been stated, it is not the writer's intention to include in this paper a complete list of insects which have been collected on cotton and which are capable of doing damage. Only those concerning which definite observations have been recorded are mentioned herein. In comparison with the humid cotton belt it is interesting to note that to date the arid Southwest has a list of 20 species of insects which can be definitely recognized as pests of cultivated cotton and in addition two species of insects and one mite which are pests of Thurberia or Arizona wild cotton, making a total of 23.

East of the ninety-eighth meridian there are at least 42 insect pests and one mite concerning which we have definite records of appreciable injury to cotton.

The order Lepidoptera leads in both sections, having 18 in the East and eight in the West. The order Hemiptera follows with 11 in the East and six in the West.[1] Four representatives of the order

[1]Including one which is common in the arid Southwest of this country and which is known as a cotton pest from observations in arid northern Mexico, which in a general way belongs to the same cotton zone.

Orthoptera are listed for each section. Of the Coleoptera there are six eastern cotton enemies and two western—counting *Anthonomus grandis* and *A. grandis thurberiæ* as two species. The order Hymenoptera contributes two species to the list of cotton enemies in the East and none in the West, Homoptera two in the East and one in the West, Thysanoptera none in the East and one in the West. Of the Acarina there is one species which has proven injurious to cotton in the East and one in the West—this latter one being confined at present to wild cotton.

Eight species are injurious to cotton in both the humid and arid sections while at least two of the eastern species, the false chinch bug (*Nysius angustatus*) and the two-spotted red spider (*Tetranychus bimaculatus*), are common in some and probably all of the cotton growing localities of the arid Southwest but have not yet proven injurious.

A survey of the insect enemies of cotton is of special interest at this time when the industry is confronted with the most serious menace which has ever appeared on the North American continent. The presence of the pink bollworm (*Gelechia gossypiella*) in the Laguna district of northern Mexico (23) calls for the most vigorous measures for its extermination for the protection of the cotton industry of the United States, whatever difficulties may be involved in a problem of this kind on foreign soil and even if the expense amounts to ten million dollars or to twice this amount. Even the entrance of our country into a great war in the interests of humanity should not blind us to the danger in the existence of this insect at our very doors. There is no single product of the soil which is of as great importance and so indispensable to mankind as cotton and with our past experience with the Mexican boll weevil and the extensive investigation of miscellaneous cotton pests made during the past few years it is now generally acknowledged, East and West, even in new cotton-growing districts, that the continued success of this great industry is more dependent on the exclusion, control and eradication of insect pests than on any other factor.

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(5) Cook, O. F. A Wild Host Plant of the Boll Weevil in Arizona. Science n. s., vol. 27, No. 946, pp. 259–261. February, 1913. This article contains the first record of the occurrence of a weevil attacking *Thurberia thespesiodes* in Arizona.

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(7) Coit, J. E. and Packard, W. E. Imperial Valley Settlers Crop Manual. Bul. 210, Cal. Agr. Exp. Sta., pp. 184, 181 and 240. January, 1911. Injury by bollworm to corn and tomatoes in the Imperial Valley is mentioned in this bulletin but no mention made of injury to cotton. Injury by *Heliothrips fasciatus* to cotton leaves is reported.

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(14) Morrill, A. W. Cotton Pests, Fifth Annual Report, Ariz. Comm. Agr. & Hort., pp. 38–48. December, 1913. A discussion of the bollworm, cotton leafworm, and two grasshopper pests (*Schistocerca vega* and *S. shoshone*) of cotton and their remedies, also of *Anthonomus grandis thurberiæ,* the Thurberia or wild cotton bollworm and the Thurberia blister mite (*Eriophyes sp.*). The following cotton pests are mentioned: cotton boll cutworm (*Prodenia ornithogalli*); the Mexican Conchuela; the grain bug; leaf-footed plant bug (*Leptoglossus zonatus*); the bordered plant bug (*Euryopthalmus succinctus*); the cotton aphis (*Aphis gossipii*) and the cotton red spider (*Tetranychus bimaculatus*). Injury to cotton by *Microthrips piercei* on one occasion is noted.

(15) Morrill, A. W. Cotton Pests, Sixth Annual Report, Ariz. Comm. Agr. & Hort., pp. 37–46. December, 1914. A discussion of the cotton aphis injury at Yuma in 1914 and relation of *Hippodamia convergens* to its control, of the salt marsh caterpillar, cotton leafworm, cotton bollworm, the differential grasshopper (*Melanoplus differentialis*) and the cotton leaf perforator.

(16) Morrill, A. W. Cotton Pests, Seventh Annual Report, Ariz. Comm. Agr. & Hort., pp. 41, 43–45. December, 1915. Includes a discussion of a tarnished plant bug (determined as *Lygus* sp. near *pratensis*) with mention of the cotton leaf perforator, the red spider (*Tetranychus bimaculatus*) and the bollworm.

(17) Morrill, A. W. Cotton Pests, Eighth Annual Report, Ariz. Comm. Agr. & Hort., pp. 45–49. December, 1916. Includes an extended discussion of cotton stainer injury to cotton bolls with special reference to the Arizona cotton stainer (*Dysdercus albidiventris*), also notes concerning the scarcity of the cotton leaf perforator in 1916 evidently as a result of control by parasites and of the occurrence on cotton in southern Arizona in 1916 of the bollworm, pentatomid bugs, cutworms and *Coryzus validus.*

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(19) Pierce, W. D. and Morrill, A. W. Notes on the Entomology of the Arizona Wild Cotton. Proc. Ent. Soc. Wash., vol. XVI, No. 1, pp. 14–23. March, 1914. This consists in a report on explorations and observations made by the authors in 1913. Notes are included on the wild cotton boll weevil, the cotton leafworm, the Thurberia bollworm, a blister mite, a Cecidomyid gall maker, a mealy-bug, the cotton leaf perforator or bucculatrix and a lepidopterous leaf folder (*Dichomeris deflecta*). A total of eighty-three different species of insects and mites are mentioned including twenty-five which may be classed as injurious.

(20) Russell, H. M. The Bean Thrips. Bul. 118, Bur. Ent., U. S. D. A., p. 30. October, 1912. This bulletin contains four paragraphs quoted from notes by V. L. Wildermuth concerning injury by the bkan thrips (*Heliothrips fasciatus*) to cotton in the Imperial Valley during 1910 and 1911.

(21) Quaintance, A. L. and Brues, C. T. The Cotton Bollworm. Bul. 50, Bur. Ent., U. S. D. A., pp. 28, 29. 1905. Contains on pages mentioned a brief statement concerning status of the bollworm in the Lower Sonoran area of the lower Austral life zone.

(22) Townsend, C. H. T. The Cotton Square Weevil of Peru and its Bearing on the Boll Weevil Problem of North America. Jour. Econ. Ent., vol. 4, No. 2, pp. 244–248. April, 1911. The writer presents his views in regard to the future development of cotton growing in the arid Southwest with special reference to the supposed immunity of this section to the cotton boll weevil (*Anthonomus grandis*).

(23) ———. Pink Bollworm. Jour. Econ. Ent., vol. X, No. 1, p. 225. A note concerning presence of *Gelechia gossypiella* in northern Mexico.

Chairman A. W. Morrill: The next paper on the program will be presented by Dr. H. H. P. Severin.

MEDITERRANEAN FRUIT-FLY (CERATITIS CAPITATA WIED.) BREEDS IN BANANAS

By Henry H. P. Severin, Ph. D.

In an article entitled, "Banana as a Host Fruit of the Mediterranean Fruit-Fly," Back and Pemberton (1, p. 802) "seriously question the statement" made in one of my publications (6, p. 70) that the "fruit-fly was also bred from a half-ripe banana under field conditions." Four scientists have bred the Mediterranean fruit-fly from bananas. Back and Pemberton, however, endeavor to cast doubt upon the results obtained by three of these naturalists. The reader is entitled to the data which I shall quote from scientific journals and correspondence.

My seriously questioned statement, that the "fruit-fly was also bred from a half-ripe banana under field conditions," was published in an article (6) which was read in more expanded form before the American Association of Economic Entomologists. Since the editor of the Journal of Economic Entomology, in which this article was published, requested me to give a brief summary of the paper read, the sentence in question was condensed from several statements published in an earlier and more detailed paper (5).

I quote verbatim the statements which were published in my summarized paper (6): "In the last number of the Journal of Economic Entomology, V, No. 6, pages 443–451, we published a paper entitled, 'Will the Mediterranean Fruit-Fly (*Ceratitis capitata* Wied.) Breed in Bananas under Artificial and Field Conditions?' There is no question of doubt but that the Mediterranean fruit-fly will occasionally breed in ripe and over-ripe bananas under Hawaiian conditions. The fruit-fly was also bred from a half-ripe banana under field conditions." It is evident that I referred the reader in my summarized paper (6) to the earlier and more detailed paper (5).

I now quote the statements which were published in our earlier and more detailed paper (5, p. 448): "During the mosquito campaign, when the banana trees were cut down in Honolulu, hundreds of bunches of bananas were examined to see if there was any evidence that the pest was breeding in bananas under field conditions. Hundreds of bananas containing maggots were removed from these bunches and placed in jars containing sterilized sand. From these bananas a small number of Mediterranean fruit-flies, numerous specimens of an Anthomyid, *Acritochæta pulvinata* Grims.; two species of Ortalidæ, *Euxesta annonæ* Fabr. and *Notogramma stigma* Fabr., and a number of species of Drosophilidæ were bred. The fruit-flies were bred from but two bananas, one of which when taken from the bunch was

decayed at the flower scar and had a bruise extending through the peel. This banana when removed from the bunch was yellow in color beneath the decayed area and gradually shaded over to green towards the other end." It was this banana which I referred to as a half-ripe banana in the previous quoted paragraph. It is evident that the Mediterranean fruit-fly was not bred from bananas growing under natural conditions, due to the fact that the fruit was removed from bunches on trees that had been cut down.

Back and Pemberton (1, p. 802) also write, "The fact that Severin reared numerous specimens of the decay flies, *Acritochæta pulvinata*, *Euxesta annonæ* Fab., and *Notogramma stigma* Fab., besides a number of species of Drosophilidæ, is ample evidence that the trees from which the two fruits were taken had been cut sufficiently long for decay to have started in many fruits, had he not stated that one of the two fruits from which he reared adult flies was in a bruised and decaying condition and that its pulp had already turned yellow beneath the decayed area." In their evidence submitted, however, the authors fail to take into consideration that we (5, p. 448) have published the fact that "the Anthomyid and two species of Ortalids mentioned above were also bred frequently from green Chinese bananas removed from bunches on growing trees in banana plantations. These bananas were decayed around the flower scar. . . ."

Kirk (3, p. 9), of New Zealand, was forced to burn consignments of fruits, including the banana, because they were infested with the maggot of the Mediterranean fruit-fly. Back and Pemberton (1, pp. 801–2) state that "from the arrangement of the text of Kirk's bulletin, the Mediterranean fruit-fly (*Ceratitis capitata*) is definitely listed as a banana pest. The bulletin is, however, a compilation taken for the most part verbatim from various articles on fruit-flies appearing in the Reports of the Agricultural Department of New Zealand, or from circulars issued by the department. A person unfamiliar with the Australian situation is at a loss to know to which of several fruit-fly pests reference is made in the reports of fruits found infested by maggots at the ports of entry. Thus, in the Thirteenth Volume of the Agricultural Reports, 1905, where the list including the banana among those fruits found infested was originally published, no reference is made to either the Queensland or the Mediterranean fruit-fly; it is merely stated that the fruits listed were burned because found infested with the 'dread maggot.' In the report for 1906 it is definitely stated that only the Queensland fruit-fly (*Dacus tryoni*) was reared that year from a list of fruits including the banana. The biologist of Western Australia in his report for the year 1898 stated that the Queensland fruit-fly had been brought to Western Australia in bananas."

In order to convince the most skeptical that the Mediterranean fruit-fly was bred from bananas by Kirk, of New Zealand, I shall publish the following sentences from a letter written March 5, 1913, by Kirk to me on this subject: "The Mediterranean fly which is mentioned in my reports as having been obtained from bananas and pineapples were bred from maggots obtained from imported fruit of those varieties. I cannot now state positively the variety of banana. . . ."

Back and Pemberton (1, p. 802) write, "French, of Victoria, Australia, states that adults of the pest were reared from bananas (*Musa* sp.) exported from Queensland, Australia, and that on many occasions he has proved eggs to have been deposited in green bananas before shipment from Queensland to Melbourne. Both Kirk and French are aware that the Queensland fruit-fly (*Dacus tryoni*) is a pest of bananas grown in Queensland and that confusion between the two fruit-flies might occur if observations were made by untrained inspectors."

The following quotation shows that French (2, p. 4) and his son conducted the breeding experiments of the Mediterranean fruit-fly from bananas on one occasion at least: "The following is an account of some experiments, dealing with the Mediterranean fly, which were carried out by the Assistant Entomologist (Mr. C. French, jun.) and myself during 1906."

"The larvæ of this fly were found in bananas imported from Queensland on the 14th August, and on being placed in the breeding jars pupated on the 20th August; the perfect insects emerged on the 4th October and lived for several weeks, water, with a little sugar added, being the food placed at their disposal."

In the Hawaiian Islands certain varieties of bananas are not immune from the attacks of the Mediterranean fruit-fly under natural conditions. Mr. J. C. Bridwell, formerly in connection with the Hawaiian Board of Agriculture, bred the Mediterranean fruit-fly from ripe bananas of the Popoulu variety and from a green Moa variety. The Moa variety, however, was mature and about to turn yellow and in addition, the peel was so cracked that the pulp was well exposed (1, pp. 795–6).

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Chairman A. W. Morrill: As we shall probably have plenty of time we might as well discuss the papers as we go along. Discussions are now in order.

Mr. Dudley Moulton, Prof. R. W. Doane, E. O. Essig and Dr. Severin took part in the discussion which followed.

Chairman A. W. Morrill: The next paper will be read by Mr. G. F. Ferris.

METHODS FOR THE STUDY OF MEALY-BUGS

By G. F. Ferris, *Stanford University, California*

The economic importance, both actual and potential, of certain of the mealy-bugs renders the problem of recognizing the various species one of more than merely academic interest. It is the problem of discriminating between foe and foe or foe and neutral and thus it is of direct interest and of directly perceptible importance to the economic entomologist especially in California where certain species of mealy-bugs are among the worst of pests.

However, it is no exaggeration to say that of the nearly 100 species of mealy-bugs and their allies thus far described from North America, including some 35 from California, not more than three or four are recognizable at all on the basis of the existing literature if taken apart from their typical host and their type locality. Furthermore these three or four are not at all times and under all circumstances recognizable with certainty, even upon the basis of the direct comparison of specimens, by means of the methods and the characters at present in use.

In support of this latter statement I may adduce as evidence the fact that I have at hand at the present time a slide mount of a Pseudococcus determined by one who is perhaps as familiar with the mealy-bugs of this state as anyone and labeled "*Pseudococcus citri.*" The slide contains four specimens and of these three are *Pseudococcus longispinus* and one is *Pseudococcus obscurus*, or as it is better known, *Pseudococcus bakeri*. This is a confusion of three of the most widely spread and most familiar species of the state. Nor is this by any

means an isolated instance of the confusion of these species. To emphasize further the degree of confusion that exists in this group it may be added that the material labeled "type" of one species described from this state contains specimens of three species belonging to as many different genera. Another species is based upon the male of a Ceroputo and the female of a Pseudococcus and there are at least two others which appear to be based upon two different species.

The existence of the present unsatisfactory conditions affords grounds for a justly severe criticism of the methods of systematic entomology as they have been applied in this particular group. However, this is a question which it would be out of place to pursue further. The present paper is concerned only with a consideration of the means by which the existing conditions may perhaps be changed for the better.

The present confusion may be ascribed to two factors, operating both separately and together.

Of these factors one is to be found in the continued use by coccidologists, as specific criteria, of the relative lengths of the segments of the antennæ, expressed in the so-called antennal formulæ. The weakness of these antennal formulæ as diagnostic characters has been implied or even openly admitted even by those who have most consistently clung to them and has been most conclusively demonstrated by Smith[1] who found that the formulæ of ten antennæ of each of five species of Pseudococcus "varied as much as the specifically diagnostic formulæ published for all the species of Pseudococcus." Yet it is upon such characters as these that most authors have based their new species and their discussions in regard to specific relationships. Other characters usually given as supplementary to the antennal formulæ are equally non-significant, as was also pointed out by Smith in the paper already referred to.

Attempts have been made to refine the usual method of presenting these antennal formulæ by embodying them in graphs, but the result is hardly satisfying for no clue is afforded by these graphs to the specific identity of the individuals upon which the graph is based. Inasmuch as two or even more species may occur together upon the same host this objection is serious. Furthermore, the construction of such graphs requires several individuals and does not aid in the identification of isolated specimens.

The effect of the use of these formulæ has been not only to render useless practically all the published descriptions but also, because of the painfully evident variability of the antennæ, to induce the belief that the mealy-bugs are inherently variable in all their structures,

[1] Smith, P. E. Specific Characters Used in the Genus Pseudococcus. Annals Entomological Society of America, vol. 4, pp. 309–327. (1911.)

and present no stable characters upon which determinations may be based. As a matter of fact such a conclusion is very far indeed from the actual facts.

The second factor, and that with which this paper is really concerned, lies in the lack of a satisfactory technique for the preparations of specimens for study. The usual method has been to clear the specimens in caustic potash and then to mount in balsam or to mount in balsam without clearing, the results in either case not being especially fortunate. In some cases the specimens become so clear that it is even difficult to find them on the slide and in no case can anything more than the antennæ and legs be seen without an inordinate amount of eyestraining. In nearly all cases the characters that are actually of the greatest value can not be seen at all. Because of all this, determinations made by the comparison of specimens with types are frequently no more to be relied upon than those made upon the basis of the literature.

The solution of the difficulty lies in the utilization of a means of staining the specimens in order to accentuate the characters that are of especial importance. This is a method that has not usually been popular, probably in part because the methods usually recommended are more or less time consuming and in part because it has not really been shown that these methods produce results of any especial value.

For the staining of coccid preparations in general and for the particular method here advocated the author claims no originality whatsoever. It is believed, however, that it has not before been asserted that for the satisfactory study of mealy-bugs and their allies the use of properly stained preparations is not only desirable but is in fact necessary. It is the non-use of such methods that has previously prevented at least one author from producing results that would have rendered the present paper entirely unnecessary.

The method used has been essentially that recommended by Stafford[1] for use with Diaspine scales, but with modifications chiefly directed toward a general reduction in the amount of time consumed. It is applicable to other insects than coccids for it has proven eminently satisfactory for use with certain aphids, particularly Chermes and Phylloxera, and with the larvæ of Cecidomyidæ. The stain used is Magenta Red and may be purchased in liquid form. It should be diluted to one-half or one-fourth its original strength with water when used.

In its essentials the method is extremely simple. The specimens to be prepared are boiled in caustic potash in the usual manner and then

[1]Stafford, E. W. Studies in Diaspinine Pygidia. Annals Entomological Society of America, vol. 8, pp. 67–73. (1915.)

removed to clean water in which the body contents are washed out with more than usual care. They may then be transferred directly to the stain, which for this purpose is most conveniently contained in deep-hollow slides having a ground glass surface upon which data may be written, covered with a cover glass and set away. Six hours in the stain is sufficient, this being in strong contrast to the 100 hours recommended by Stafford. The specimens are removed from the stain into 95 per cent alcohol in which the excess stain is washed out, are then placed for an instant in carbol-xylene and mounted in balsam.

The result is a preparation in which all chitinized portions, the antennæ, legs, setæ and chitinized areas, are stained a more or less deep red while the remainder of the derm is left practically unstained. It not only becomes easier to study the characters that can be seen in the usual mounts but other characters are brought out that are not ordinarily to be seen and that have not, as far as I am aware, previously been noted by any one.

Smith[1] has pointed out the possible value as specific criteria of the "cerrari" or groups of pores and differentiated spines that occur on the margin of the body and these structures are indeed of much importance. In fact it is probable that a much more satisfactory basis for generic groupings can be found in the number of pairs of these cerrari than in the characters at present used and they are also of value for the recognition of species.

In addition to these cerrari, however, there occur in some species, certain chitinized and deeply staining areas associated especially with the cerrari of the anal lobes and on the ventral side of these lobes. It is these areas of which I have previously spoken as characters not previously noted. They are remarkably constant in shape and extent and permit the instant and certain recognition of some species. In other species they are not present, in which case the cerrari alone must be relied upon. With the use of all these characters, the cerrari, the dorsal and ventral body setæ and the chitinized areas, the distinguishing of the various species of mealy-bugs becomes in general practically no more difficult than the distinguishing of the various species of diaspine scales. The differences are readily appreciable and are no more variable than those which must be used in almost any group. Given proper study upon the basis of adequate material and with the aid of the methods here advocated, or of equivalent methods, the present confusion in the "soft scales" should rapidly disappear.

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[1] Smith, P. E. A Study of Some Specific Characters of the Genus Pseudococcus. Journal of Entomology and Zoölogy, vol. 5, pp. 69, 81, figs. (1913.)

The paper was followed by a discussion by several members as to more detail in the methods used.

CHAIRMAN A. W. MORRILL: The next paper will be presented by H. E. Burke.

NOTES ON SOME WESTERN BUPRESTIDÆ[1]

By H. E. BURKE,

Specialist in Forest Entomology, Bureau of Entomology, U. S. Department of Agriculture

During the past fifteen years various members of the Branch of Forest Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture, have made a number of observations on the life-histories and food plants of numerous species of western flathead borers or Buprestidæ. Some of these species are injurious to native and introduced fruit and shade trees and some other species may soon become so. One wood-infesting species has become a household pest and is doing some damage to interior wood work in the mountain towns.

Most of the species discussed inhabit deciduous trees but a few that may become pests of coniferous shade trees are included. In all cases the host plants listed are those from which the larva or adult has been taken from the wood or bark and not just resting on the foliage or bark. The fact that adults are found on the foliage or bark of a plant time after time is a good observation and worthy of record. It is also a good indication that the borer lives in the plant. There are cases, however, where it is not true and, in the writer's opinion, no plant should be listed as a host plant of a boring insect unless the insect is found living in the plant.

Some of the observations made on the feeding and egg-laying habits of the adults have suggested new methods of control and also, when considered with the life-history studies, new taxonomic relations.

In all, forty-four species are listed. Forty-three of these are western and from the following states: South Dakota, Montana, Colorado, New Mexico, Idaho, Utah, Arizona, Washington, Oregon and California. One southern species is included to complete the host plants of the genus Trachykele. There are no records from Wyoming and Nevada but many of the species listed undoubtedly occur in those states.

The names as given follow Henshaw's "List of the Coleoptera of America, North of Mexcio." Many of the genera are in a deplorable state but the names given are those commonly used. The doubtful species have been verified by Mr. W. S. Fisher of the Branch of Forest

[1] Published by permission of the Secretary of Agriculture.

Insect Investigations, Prof. E. C. Van Dyke of the University of California and Prof. H. C. Fall of Pasadena, California.

Dicerca prolongata Lec.—Specimens from South Dakota, Colorado, Montana, Utah, Oregon and California; mines wood of injured, dying and dead trees; willow (*Salix* sp.), aspen (*Populus tremuloides*) and black cottonwood (*P. trichocarpa*); flies from July to September; feeds on bark of host plant; may attack planted poplars.

Dicerca obscura Fab.—What appears to be this common eastern species has been taken at Chico, California, in the wood of the Oregon ash (*Fraxinus oregona*); mines wood of injured, dying and dead trees; the eastern host plants are white oak (*Quercus alba* Linn.) and persimmon (*Diospyros virginiana*); flies from April to September. May become injurious to planted oak, ash and persimmon.

Dicerca hornii Cr.—Montana, Idaho, Washington, Oregon and California; mines wood of injured, dying and dead trees and shrubs; white alder (*Alnus rhombifolia*), mountain alder (*A. tenuifolia*), mountain mahogany (*Cercocarpus parvifolius*), plum (*Prunus domestica*), sweet cherry (*P. avium*), sumach (*Rhus glabra occidentalis*), poison oak (*Toxicodendron diversiloba*), California buckeye (*Æsculus californica*), coffee berry (*Rhamnus californica*), deer brush (*Ceanothus integerrimus*), blue brush (*C. thyrsiflorus*), buck brush (*C. cuneatus*) and snow berry (*Symphoricarpos racemosus*); flies from March to August; attacks domestic plum and cherry and probably other fruit trees; causes severe injury to the alder.

Dicerca sp. close to divaricata Say—Montana and Colorado; mines wood of dying and dead trees; mountain birch (*Betula fontinalis*), mountain alder (*Alnus tenuifolia*), bitter cherry (*Prunus emarginata*) and choke cherry (*P. demissa*); flies from July to September; may attack planted birches and rosaceous fruit trees.

Trachykele blondeli Mars.—Washington, Oregon and California; mines wood of normal, injured, dying and dead trees; giant arborvitæ (*Thuja plicata*), monterey cypress (*Cupressus macrocarpa*), McNab cypress (*C. macnabiana*) and western juniper (*Juniperus occidentalis*); flies from April to August; attacks planted cypress and probably other planted cedarlike trees.

Trachykele opulenta Fall—California; mines wood of normal, injured, dying and dead trees; California bigtree (*Sequoia washingtoniana*) and incense cedar (*Libocedrus decurrens*); flies April to June; attacks planted incense cedar and probably bigtree and redwood.

Trachykele nimbosa Fall—Oregon and California; mines wood of normal, injured, dying and dead trees; alpine hemlock (*Tsuga mertensiana*), white fir (*Abies concolor*) and red fir (*A. magnifica*); flies during June and July; may attack planted fir.

Trachykele lecontei Gory—Virginia, North Carolina, South Carolina and Louisana; mines wood of injured, dying and dead trees; bald cypress (*Taxodium distichum*); flies from March to July; may attack planted bald cypress.

Pœcilonota cyanipes Say (?)—Colorado, New Mexico and Utah; mines wood of injured trees; aspen (*Populus tremuloides*) and common cottonwood (*P. deltoides*); flies from August to September; may attack planted poplars.

Pœcilonota ferrea Melsh. (?)—California; mines bark and wood of injured trees; aspen (*Populus tremuloides*) and nuttall willow (*Salix nuttallii*); flies from July to September; may attack planted willows and poplars.

Pœcilonota thureura Say (?)—Montana and Oregon; mines bark of normal trees; black cottonwood (*Populus trichocarpa*); flies in July and August; lays its eggs in crevices in the bark; may attack planted cottonwoods but according to Mr. Josef Brunner prefers the older thick-barked trees.

The classification of this genus is in a deplorable state and all of these species may be wrongly identified.

Buprestis confluens Say—Colorado, Utah and California; mines wood of injured, dying and dead trees; aspen (*Populus tremuloides*) and common cottonwood (*P. deltoides*); flies from July to September; attacks planted cottonwood.

Melanophila drummondi Kirby—Practically all of the Rocky Mountain and Pacific states; mines inner bark and outer wood of normal, injured, dying and dead trees; western larch (*Larix occidentalis*), Engelmann spruce (*Picea engelmanni*), sitka spruce (*P. sitchensis*), western hemlock (*Tsuga heterophylla*), alpine hemlock (*T. mortensiana*), douglas spruce (*Pseudotsuga taxifolia*), alpine fir (*Abies lasiocarpa*), lowland fir (*A. grandis*), white fir (*A. concolor*), lovely fir (*A. amabilis*), noble fir (*A. nobilis*) and red fir (*A. magnifica*); flies from May to September; attacks and kills many trees, also causes defects to form in the wood of others; may attack coniferous shade trees.

Heretofore, has been mixed with the following species. *Melanophila sp.*—California; mines inner bark and wood of normal, injured, dying and dead trees; yellow pine (*Pinus ponderosa*), jeffrey pine (*P. jeffreyi*) and digger pine (*P. sabiniana*); flies from June to August; kills many second growth trees and assists Dendroctonus species to kill others.

Melanophila gentilis Lec.—Practically all of the Rocky Mountain and Pacific states; mines inner bark and wood of normal, injured, dying and dead trees; sugar pine (*Pinus lambertiana*), yellow pine (*P. ponderosa*), rock pine (*P. scopulorum*) and jeffrey pine (*P. jeffreyi*);

flies from March to August: attacks and kills small and large trees; very injurious to second growth in some localities; is the principal enemy of the sugar pine outside of *Dendroctonus monticolæ* Hopk.

Melanophila intrusa Horn—Colorado and California; mines inner bark of injured, dying and dead trees; sugar pine (*Pinus lambertiana*), yellow pine (*P. ponderosa*) and rock pine (*P. scopulorum*); flies in June and July; usually lives in the suppressed limbs and tops but sometimes infests saplings; the larva indicates that it is quite different from the other Melanophila.

Anthaxia œnogaster Lap.—Practically all of the Rocky Mountain and Pacific states; mines bark and outer wood of normal, injured, dying and dead trees and shrubs; sugar pine (*Pinus lambertiana*), pinon pine (*P. edulis*), yellow pine (*P. ponderosa*), jeffrey pine (*P. jeffreyi*), digger pine (*P. sabiana*), knobcone pine (*P. attenuata*), Monterey pine (*P. radiata*), douglas spruce (*Pseudotsuga taxifolia*), weeping willow (*Salix babylonica*), garry oak (*Quercus garryana*), mountain mahogany (*Cercocarpus parvifolius*), service berry (*Amelanchier alnifolia*) and redbud (*Cercis occidentalis*); flies from March to September; commonly lives in the branches but often attacks and kills saplings and shrubs; very injurious to the redbud in some localities. It appears to the writer that there must be several species mixed.

Chrysobothris femorata Fab.—Montana, Colorado, Idaho, Arizona, and California; mines inner bark and wood of normal, injured, dying and dead trees; willow (*Salix* sp.), aspen (*Populus tremuloides*), black cottonwood (*P. trichocarpa*), lombardy poplar (*P. nigra italica*), gambel oak (*Quercus gambeli*), live oak (*Q. chrysolepis*), black oak (*Q. californica*), wild plum (*Prunus americana*), prune (*P. domestica*) and imported maple (*Acer dasycarpum*); flies from March to September; sometimes causes severe injury to poplar and maple shade trees as well as fruit trees. Many of the published records of this species in the west refer to *Chrysobothris mali*.

Chrysobothris mali Horn—Oregon and California; mines inner bark and wood of normal, injured and dying trees and shrubs; arroyo willow (*Salix lasiolepis*), mountain mahogany (*Cercocarpus parvifolius*), apple (*Pyrus malus*), christmas berry (*Heteromeles arbutifolia*), plum (*Prunus domestica*), wild plum (*P. subcordata*), peach (*P. persica*), Oregon maple (*Acer macrophyllum*) and box elder (*A. negundo*); flies from May to August; lays its eggs singly in crevices in the bark; causes severe injury to shade and fruit trees; all of the Chrysobothris reared from the apple in California by the writer are of this species. These rearings were from Siskiyou, El Dorado and Los Angeles counties.

Chrysobothris nixa Horn—California; mines inner bark and wood of normal, injured, dying and dead trees; incense cedar (*Libocedrus decur-*

rens) and monterey cypress (*Cupressus macrocarpa*); flies from March to August; kills saplings and small trees. Very common in felled incense cedar. Reared once from the monterey cypress by Mr. F. B. Herbert.

Thrincopyge ambiens Lec.—Arizona; mines flower stems of the sotol (*Dasylirion wheeleri*); flies July and August; may infest yuccas and closely related plants.

Polycesta californica Lec.—Oregon and California; mines wood of injured, dying and dead trees and shrubs; cottonwood (*Populus fremonti*), white alder (*Alnus rhombifolia*), garry oak (*Quercus garryana*), douglas oak (*Q. douglasii*), interior live oak (*Q. wislizeni*), black oak (*Q. californica*), mountain mahogany (*Cercocarpus parvifolius*), apple (*Pyrus malus*), pear (*P. communis*); christmas berry (*Heteromeles arbutifolia*), almond (*Prunus amygdalus*), redbud (*Cercis occidentalis*), Oregon maple (*Acer macrophyllum*) and manzanita (*Arctostaphylos viscida*); no specimens collected flying; emerges from host plant early in summer; causes some injury to fruit and shade trees.

Polycesta elata Lec.—Arizona; mines wood of injured, dying and dead trees; Arizona white oak (*Quercus arizonica*), emory oak (*Q. emoryi*), white leaf oak (*Q. hypoleuca*), hackberry (*Celtis reticulata*) and Arizona sycamore (*Plantanus wrightii*); no specimens collected flying; causes some injury to shade trees.

Polycesta velasco L. & G.—Arizona; mines wood of injured, dying and dead trees; catsclaw (*Acacia greggii*), mosquite (*Prosopis juliflora*) and palo verde (*Cercidium torreyanum*); no specimens collected flying; causes some injury to shade trees; may attack introduced acacias.

Acmæodera amabilis Horn—Arizona; mines wood of dead trees; alder (*Alnus tenuifolia*); may attack shade trees.

Acmæodera plagiaticauda Horn—California; mines wood of injured shrubs; manzanita (*Arctostaphylos viscida*); may injure planted shrubs.

Acmæodera angelica Fall—California; mines wood of injured and dying trees and shrubs; douglas oak (*Quercus douglasii*), poison oak (*Toxicodendron diversiloba*), deer brush (*Ceanothus integerrimus*) and buck brush (*C. cuneatus*); may injure planted oaks and shrubs.

Acmæodera hepburnii Lec.—California; mines wood of injured and dying trees; garry oak (*Quercus garryana*), douglas oak (*Q. douglasii*), interior live oak (*Q. wislizeni*) and pear (*Pyrus communis*); flies in May and June; injures fruit and shade trees by mining the wood and weakening the trunk.

Acmæodera acuta Lec.—California; mines wood of injured and dying trees; douglas oak (*Quercus douglasii*); may injure planted trees.

Acmæodera connexa Lec.—California; mines wood of injured trees; interior live oak (*Quercus wislizeni*); flies from May to July; injures shade trees.

Acmæodera van dykei Fall—California; mines wood of injured roots; interior live oak (*Quercus wislizeni*); flies from May to July; may attack shade trees.

Acmæodera cuneata Fall—Arizona; mines wood of injured and dying trees; alder (*Alnus tenuifolia*); may attack shade trees.

Acmæodera sp. near prorsa Fall.—California; mines wood of scars on living trees; interior live oak (*Quercus wislizeni*) and black oak (*Q. californica*); may injure shade trees.

Acmæodera mariposa Horn—Oregon and California; mines wood of injured and dying shrubs; mountain mahogany (*Cercocarpus parvifolius*), christmas berry (*Heteromeles arbutifolia*), poison oak (*Toxicodendron diversiloba*), coffee berry (*Rhamnus californica*), deer brush (*Ceanothus integerrimus*), blue brush (*C. thyrsiflorus*) and redbud (*Cercis occidentalis*); flies from April to June; feeds on the foliage of the hostplant; may attack planted shrubs.

Acmæodera sp. near pulchella Herbst.—Colorado and Utah; mines wood of injured and dying trees; gambel oak (*Quercus gambelii*); flies in July; may attack shade trees.

Chrysophana placida Lec.—Colorado, Utah, Washington, Oregon and California; mines cones and wood of normal, injured, dying and dead trees; mountain white pine (*Pinus monticola*), sugar pine (*P. lambertiana*), single leaf pinon (*P. monophylla*), yellow pine (*P. ponderosa*), rock pine (*P. scopulorum*), jeffrey pine (*P. jeffreyi*), lodgepole pine (*P. murrayana*), digger pine (*P. sabiniana*), knobcone pine (*P. attenuata*), alpine hemlock (*Tsuga mertensiana*), douglas spruce (*Pesudotsuga taxifolia*), alpine fir (*Abies lasiocarpa*), white fir (*A. concolor*), red fir (*A. magnifica*) and giant arborvitæ (*Thuja plicata*); flies from March to September; is destructive to seed crop of knobcone pine; damages pine window and door casings in buildings and may attack wood of planted coniferous trees.

Agrilus angelicus Horn—California; mines twigs and small branches of normal trees; live oak (*Quercus agrifolia*); flies from May to July; feeds on the foliage of the host plant; lays its eggs singly on the outer bark of the twigs; girdles and kills twigs and small branches; damages shade trees by causing a ragged or scraggy appearance; takes two years for the life cycle. The published records on this distinct species are under *Agrilus politus* Say.

Agrilus sp.—California; mines bark and wood of branches and main trunks of normal shrubs and trees; madrone (*Arbutus menziesii*) and manzanita (*Arctostaphylos manzanita* and *A. viscida*); flies from May to August; feeds on the foliage of the host plant; lays its eggs singly on the smooth bark of the branches and trunk; girdles and kills branches and causes the formation of enlarged galls; takes two years for the life

cycle; may damage ornamental shrubs and shade trees. Some taxonomists consider this the same as the preceding species but the life-history and habits indicates that it is distinct.

Agrilus niveiventris Horn—California; mines inner bark and wood of normal and dying trees; lombardy poplar (*Populus nigra italica*); flies from May to August; feeds on the foliage of the willow (*Salix lasiandra* and *S. lasiolepis*) and the host plant; lays its eggs singly in crevices in the bark; girdles and kills shade trees, sometimes causing severe damage.

Agrilus granulatus Say—Colorado and Montana; mines inner bark and wood of normal, dying and dead trees; willow (*Salix* sp.), black cottonwood (*Populus trichocarpa*) and common cottonwood (*P. deltoides*); girdles and kills limbs and trunk. Injurious to shade trees in Colorado.

Agrilus anxius Gory—South Dakota, Montana, Colorado, Idaho and Utah; mines inner bark and wood of normal, dying and dead trees; aspen (*Populus tremuloides*), common cottonwood (*P. deltoides*) and mountain birch (*Betula fontinalis*); flies from May to August; girdles and kills branches and trunk; causes severe damage to shade trees.

Agrilus acutipennis Mann.—Colorado; mines inner bark and wood of normal, injured and dying trees; gambel oak (*Quercus gambelii*); flies from June to August; feeds on the foliage of the host plant; lays its eggs in the crevices of the bark; girdles and kills branches and trunk; very destructive to native groves of oak in Colorado according to Mr. George Hofer.

Agrilus politus Say—Montana, Colorado, Oregon and California; mines inner bark and wood of normal, injured and dying trees and shrubs; mountain willow (*Salix monticola*), nuttall willow (*S. nuttallii*), arroyo willow (*S. lasiolepis*), weeping willow (*S. babylonica*), mountain alder (*Alnus tenuifolia*) and dwarf maple (*Acer glabrum*); flies from May to August; feeds on foliage of host plant; lays its eggs in masses of from one to twelve on the smooth bark of branches and trunk; girdles and kills branches and main trunk; life cycle appears to vary; Mr. Josef Brunner considers it to be two years in Montana but it seems to be only one in some parts of California; very destructive to alder in some parts of Montana and to willow in California; attacks weeping willow shade trees. There may be several species still mixed under this name. In practically all of our rearings greenish specimens occasionally appear. These have been identified by Mr. W. S. Fisher as *Agrilus solitarius* G. & H. The next species which is dark blue has also been considered a variety of politus but the life history and habits indicate that it is distinct.

Agrilus sp.—Oregon and California; mines inner bark and wood of

normal, injured and dying trees; white alder (*Alnus rhombifolia*) and mountain alder (*A. tenuifolia*); flies from April to July; feeds on foliage of host plant; lays its eggs in masses of from one to twelve on the smooth bark of branches and trunk; girdles and kills branches and trunk; life cycle seems to be one year; very destructive to the white alder in some parts of California; when an attack does not kill the tree it causes rough scars on the trunk and swollen galls on the branches; appears to be the only species that attacks the alder in California.

From an economic standpoint the two main points brought out by the preceding observations are: first, that the adults of some of the most injurious species feed on the foliage of the host plant where they may be fought with poison sprays; second, that they lay their eggs upon the bark where they may be reached by contact sprays.

Up to the present time the general methods of control recommended for flathead borers have been the cutting out and burning of the infested parts or the protection of the plant by repellent washes or protective coverings. These methods when carefully applied are very effective and will continue to be important but along with them the measures suggested in the preceding paragraph have their place and in many cases their prompt use ought to make the severer measures unnecessary.

Take, for instance, *Agrilus politus* which causes severe damage to the alder and willow often killing many trees in a group. The adults feed on the leaves and then lay their eggs on the smooth bark of the limbs and main trunk. An arsenic spray on the foliage should kill the adults and any of the oil or sulphur sprays should destroy the eggs on the bark. And the result should be the same in the case of *Chrysobothris mali* which is a destructive enemy of shade and fruit trees.

The main point in the use of any of these measures is careful observation to determine the amount of damage the insect is doing, the exact time when the control work should be done, that the proper method is selected to suit the particular conditions found and that the method used is properly applied. The most perfect remedy will not bring the best results unless it is used in the right place at the right time.

Chairman A. W. Morrill: As it is now lunch time we had better adjourn until 2 p. m. as announced on the program.

Adjourned

After a very fine luncheon provided by the members of Stanford University for all members of visiting societies the meeting was called to order at 2 p. m. by Chairman A. W. Morrill.

Chairman A. W. Morrill: The first paper for this afternoon will be read by Dr. H. H. P. Severin.

FRUIT-FLIES OF ECONOMIC IMPORTANCE IN CALIFORNIA

By Henry H. P. Severin, *Berkeley, Cal.*

(Withdrawn for publication elsewhere)

The paper was discussed by H. E. Burke, A. W. Morrill, R. W. Doane and others.

Chairman A. W. Morrill: The next paper, by Prof. A. L. Lovett, will be read by the secretary.

NICOTINE SULPHATE AS A POISON FOR INSECTS

A. L. Lovett, *Entomologist, Oregon Agricultural Experiment Station*

A suggestion of nicotine sulphate as a stomach poison for insects was first brought to the writer's attention after reading the report of Mr. F. E. DeSellem, inspector at large, of North Yakima, Washington, on Black Leaf 40 as a spray for the codling moth.

Since the completion of the work included in this paper, has appeared the excellent article on "Nicotine as an Insecticide" by Mr. McIndoo, in the *Journal of Agricultural Research*, and still more recently the 1916 Horticultural Report of Yakima County, Washington, with the two seasons' rather startling results of Mr. DeSellem on the control of the codling moth. The results included in this paper supplement both in a measure and are offered as additional data on a very interesting topic. Nicotine sulphate as a contact insecticide is considered a very efficient, but expensive spray. The possibility of its broader insecticidal properties in commercial spraying as indicated in these papers may alter our present conception as to value versus service.

Series 1. For Foliage Eating Caterpillars

The caterpillars used in the tests were our common tent caterpillars (*Malacosoma pluvialis* Stretch). They were collected, tent and all, in the field feeding on the foliage of the wild rose. With the exception of Experiment A the foliage was allowed to dry for hours after applying the spray before introducing the caterpillars.

Experiment A.

April 9, 1916. 9.00 a. m.

Sprayed foliage of wild rose with "Pratt's Nicotine 40" 1–400, thoroughly saturating the foliage with a fine misty spray. Placed approximately 600 newly hatched larvæ of the tent caterpillar (*M.*

pluvialis) on the wet foliage. The caterpillars exhibited a most decided aversion to the sprayed foliage, crawling about, collecting in masses and suspending themselves on elongated web ropes and dropping off. By noon, fully 60 per cent were apparently dead, though none had fed. These died in a balled up heap in the center of the mass of foliage. The few remaining caterpillars were restless, sick and writhing about. Observations at 5.00 p. m. showed about all dead; some which had dropped apparently dead, showed signs of life, but were very sick. The next morning, April 10, all were dead or had left. A fair per cent of those which dropped had recovered and crawled away. One small incision in the margin of a leaf was observed, but there were no other apparent signs of feeding.

Experiment B.

April 13, 1916. 8.45 p. m.

Sprayed foliage of apple as follows:

No. 1, Pratt's Nicotine 40 1–800

No. 2, Black Leaf 40 1–1200

Applied as fine misty spray thoroughly saturating foliage. Placed on table to dry. April 14, 9.00 a. m., placed approximately 300 small caterpillars on each No. 1 and No. 2. Foliage perfectly dry.

The caterpillars showed a decided aversion, were restless, crawled about, formed long web ropes and dropped off. Often one would be observed to rear the head and half of the body from the foliage, writhe about and spew up drops of dark liquid as grasshoppers do, apparently very sick. At 3.00 p. m., 50 per cent were apparently dead, the others very sick. Many which had dropped and lay curled in grotesque positions as though having died in great pain, eventually recovered (after 3 hours or more) and crawled away. The following day, April 15, a few were observed to have fed on both Nos. 1 and 2. Where they had fed, they were apparently in all cases really dead. One fact stood out particularly, of the many which had dropped, apparently dead, without having fed, they had almost without exception, recovered and crawled away. The drop on No. 2 was a little heavier than on No. 1, with a little more feeding indicated on No. 1. The caterpillars were about all dead or had crawled away the next day, April 16, from both Nos. 1 and 2. To see if the action of the material was still effective, 75 fresh caterpillars were placed on No. 2. The action of the caterpillars was the same as that of earlier forms, restless, sick and dropping off. This would indicate that the action, whatever it is, extends over a period of three days at least.

Experiment C.

May 5, 1916.

Sprayed apple foliage with following:
No. 3, Black Leaf 40, 1–800
No. 4, Black Leaf 40, 1–1200

Thoroughly covered foliage with fine misty spray and allowed to dry for six hours. Placed approximately 1,000 half-mature tent caterpillars on each.

The results were practically identical with those of Experiments A and B with the immature forms. The material was apparently very repulsive, though no odor of nicotine could be detected. The foliage was placed where a breeze could blow across it. The caterpillars continued to act restless, dropped, writhed and spewed. The effect of the spray on these larger forms was slower. Also, more caterpillars were used in the tests. Daily observations were made up until May 19, a total of 14 days, when approximately all had left the sprayed foliage. Each day a number would drop, lie for approximately three hours as though dead, then recover and crawl away. Those which crawled away collected in a mass on the sill of the window. On May 10 and 11 these forms were collected and placed on fresh unsprayed foliage. Here they fed with great gusto and apparently showed no ill effects of the recent illness. On May 11, two caterpillars were found dead on No. 3; the foliage showed small feeding punctures. There were three dead on No. 4, which also showed slight evidence of feeding. The foliage was changed on May 12, first allowing it to dry thoroughly after applying the spray. On May 19, seven caterpillars were dead under No. 3 and 12 under No. 4. Feeding for the entire period amounted to a total of about two fair-sized leaves.

Experiment D.

May 19.

Dipped camel's hair brushes in Nicotine Sulphate 40 per cent and treated nearly mature caterpillars as follows:

No. 1. Black Leaf 40, 1–800, painted ventral surfaces of 10 caterpillars with moist brush and then placed caterpillars on fresh unsprayed apple foliage.

No. 2. Pratt's Nicotine 40, 1–800, allowed brush to dry for 24 hours, painted ventral surface of 10 caterpillars and placed on fresh unsprayed apple foliage.

No. 3. Black Leaf 40, 1–1200, allowed to dry 24 hours and treated as above.

No. 4. Pratt's Nicotine 40, 1–1200 treated as No. 1.

No. 1 and No. 4 nauseated, spewed up and dropped off; eventually recovered.

No. 2 and No. 3 restless for a time but eventually commenced feeding and were apparently normal. Not sick.

Conclusions

Nicotine sulphate is a very powerful repellent for caterpillars. They will not ordinarily feed from choice on foliage sprayed with it. Where feeding does take place, the action of the nicotine is apparently rapid and sure, even small bits of foliage sprayed with comparatively weak solutions, where devoured, killing after a short time. To what property of the spray one may attribute the general sick condition of the caterpillars is discussed in Mr. McIndoo's paper, page 98. Paralysis of the nerves by the volatile nicotine passing in through the tracheæ as he suggests is the most feasible explanation. The volatilization of nicotine sulphate must be very slow as this material is, theoretically, non-volatile. The possibility of the active agent being absorbed by the feet or through the skin and thus carried to the nerve centers is also suggested.

Series B, For Codling Moth

The tests of nicotine sulphate for the control of the codling moth were very unsatisfactsry and can hardly be considered good experimental data. The immediate cause for failure was an unavoidable late change in plans. The factors which make the test of little value are as follows: The orchard tract available for the test consisted of a run-down orchard of mixed varieties with their necessary individual variations. No comparison was made against the standard lead arsenate application. The nicotine sulphate was used in combination with lime-sulphur instead of soap. The season was a very backward one and the generations of the codling moth were very much delayed. A summary of the test is included in this paper that one may judge the results for whatever value they may have.

Four applications were made: 1, The calyx spray, May 10; 2, When eggs of first generation were deposited, June 16; 3, When first adults of second generation appeared, August 2; and 4, When majority of second generation moths were depositing eggs, September 8.

The following materials were used at each application:

1. Niagara dust sulphur 85 per cent plus Corona lead arsenate 15 per cent, as a dust.
2. Black Leaf 40, 1–400 plus lime sulphur 32° B., 1–35.
3. Pratt's Nicotine 40, 1–800 plus lime sulphur 32°, 1–35.
4. Black Leaf 40, 1–1200 plus lime sulphur 32°, 1–35.

While none of the materials gave satisfactory control, the comparative results are interesting. In the check, there were 29.65 per cent of wormy apples. Nicotine sulphate 1–1200 and 1–800 show but slight control, having respectively 26.8 and 26 per cent of wormy apples.

Codling Moth Experiment with Nicotine Sulphate

(*Cydia pomonella*)

(Total count 20,396 apples)

Treatment	Total Number of Apples	Sound		Unsound	
		Number	Percentage	Number	Percentage
Untreated Plat I, Baldwins	2,705	2,090	77.26	615	22.74
Untreated Plat II, Yellow Newtons	1,417	899	63.44	518	36.56
Mean			70.35		29.65
Dust (85 per cent sulphur)	513	451		62	
and 15 per cent arsenate	3,156	2,919		237	
Yellow Newtons	3,482	3,166		316	
Mean			91.39		8.61
Black leaf (1-1200), Plat No. II, Northern Spies	725 951	545 763	78.04	180 188	21.95
Black leaf (1-1200), Plat No. II, Yellow Newtons	509	348	68.36	161	31.64
Mean			73.20		26.80
Black leaf (1-400), Plat No. III, Baldwin	4,729	4,005	84.69	724	
Mean					15 31
Pratt's Nicotine 40 (1-800), Plat No. I, Yellow Newtons	711	466	65.54	245	34.45
Pratt's Nicotine 40 (1-800), Plat No. II, Baldwins	1,498	1,235	82.44	263	17.56
Mean			74.00		26.00

Nicotine sulphate 1–400 gave approximately one-half control or 15.31 per cent worms. The dust application gave by far the best control, showing only 8.6 per cent worms. The foliage of the dusted trees showed to an advantage. This material also checked the scab to a very fair degree, though the work was started too late to afford satisfactory control here.

1916. McIndoo, N. E. Effects of Nicotine as an Insecticide. Jour. Agri. Research, VII, pp. 89–121. 1916.

1916. DeSellem, F. E. Nicotine Sulphate for the Control of the Codling Moth. Yakima County Hort. Rept. 1916, pp. 62–72.

Chairman A. W. Morrill: The next paper by Prof. C. P. Gillette and L. C. Bragg will be read by the secretary.

THE MIGRATORY HABITS OF MYZUS RIBIS (LINN.)

By C. P. Gillette and L. C. Bragg

This is one of the best known aphides in both Europe and the United States, occurring upon the leaves of the various species of *Ribes*, especially the common red currant, but also known to attack the leaves of the European black currant, the Rocky Mountain wild currant, *R. aureum,* and occasionally the gooseberry.

Linnæus gave a very good description of this louse including the red leaf galls which it produces, so we are reasonably certain of the species he worked with. It has long been known that it leaves the currant bushes during the middle of the summer, but no one has definitely determined the alternate hosts.

Kaltenbach and Koch may have had this species under observation when studying *galeopsidis* on Stachys, which we have demonstrated is a common summer host of this species in Colorado.

Buckton, vol. II, pl. 39, fig. d, has evidently confounded the red leaf galls of this species with the work of *Rhopalosiphum ribis,* a fact referred to by Schouteden in his "Catalog of the Aphididæ of Belgique," p. 236.

Koch put this species in the genus *Rhopalosiphum,* probably because there is a slight enlargement of the cornicles toward the distal ends where the diameter is greatest.

Dobrovliansky, in *Review of Applied Entomology,* 1914, p. 81, is quoted as saying that this aphid is injurious to the black currant, but says nothing of the possibility of its having a different summer host.

Dr. Patch, in Bulletin 225 of the Maine Experiment Station, p. 55, 1914, mentions this as a common louse upon the currant in Maine and considers it a migrating species, but says that the alternate host plant is unknown.

Prof. H. F. Wilson, in his paper, "Biennial Crop Pests and Horticultural Report of the Oregon Agricultural College and Experiment Station," p. 94, 1912, speaks of this as a migrating species and gives a characterization of its different stages, including the egg, upon the currant, but does not suggest the summer hosts. He also mentions the gooseberry as an occasional host plant.

Van der Goot, in his paper on Blattlaus-Arten, Overgedrukt uit het Tigdschrift voor Entomologie, Deel LV, 1912, p. 72, considers *M. ribis* a migrating species and says it is possible that his *M. lamii* might be the migratory form of *ribis.*

Van der Goot, also, in "Beitrage zur Kenntnis des Hollandischen Blattlause," p. 113, 1915, reports the fall migrants of *M. galeopsidis* coming to the currant and the oviparous females laying eggs upon the

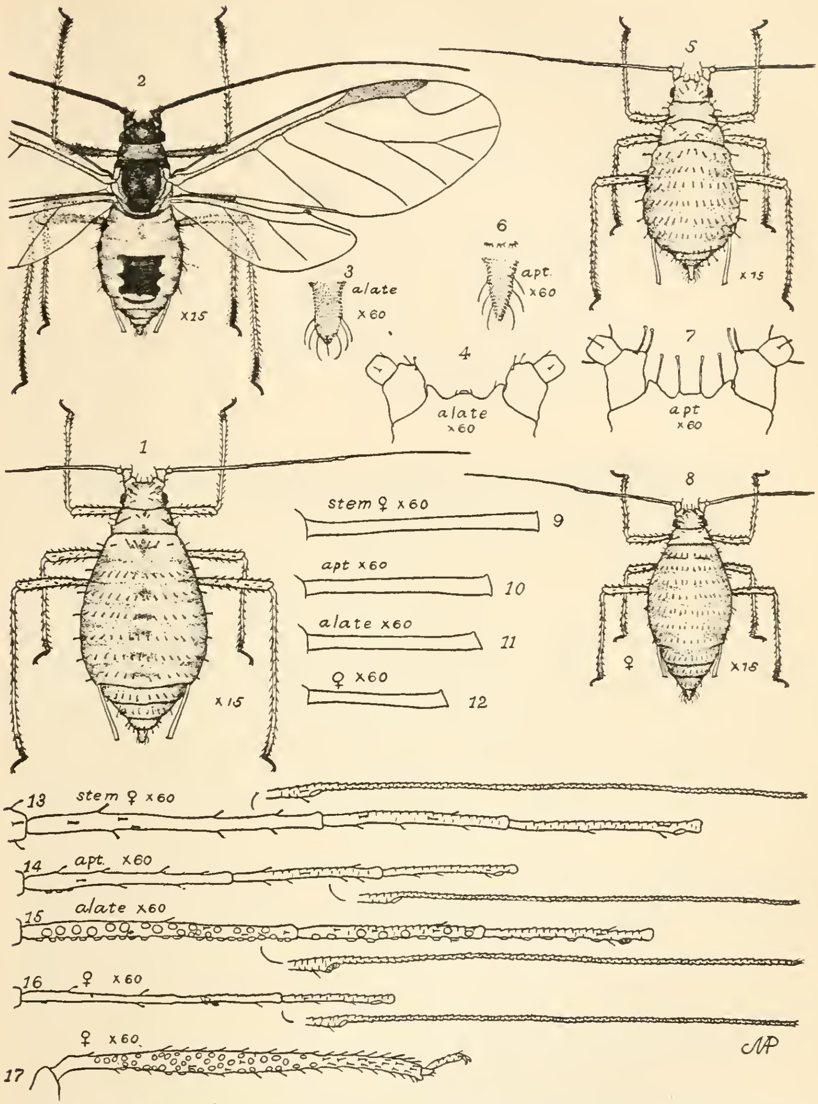

Fig. 17. *Myzus ribis* (Linn.). 1, Stem mother, 9 and 13 the cornicle and antenna of same; 2, alate viviparous female, and 3, 4, 11 and 15, the cauda, vertex, cornicle and antenna of the same; 5, apterous viviparous mother of the males, and 6, 7, 10 and 14, the cauda and gonopophyses, vertex, cornicle and antenna of same; 8, the oviparous female, and 12, 16 and 17 the cornicle, antenna and tibia of same.

Original, Miriam A. Palmer, Illustrator.

The apterous virgogene and the antenna of the alate male differ so little from figures 5 and 15 in the plate, it does not seem necessary to figure them.

twigs. He speaks of taking a similar louse upon *Lamium* and *Stachys* and makes the suggestion that it may be identical with *M. ribis*, but thinks not, as his attempts to transfer early summer—"Vorsommer"—forms to the *Lamium* did not succeed.

We have repeatedly transferred the migrants from the *Ribes* to *Stachys* and *Leonurus* and the fall migrants from these plants to the currant and had them take well, so feel safe in announcing these two genera, at least, as summer hosts of *Myzus ribis* Linn.

For structural details of this species, see Figure 17.

CHAIRMAN A. W. MORRILL: The next paper, by Professor Illingworth, will be read by the secretary.

A TROUBLESOME HOUSEHOLD PEST (ATTAGENUS PLEBIUS SHARP) OF HAWAII

By DR. J. F. ILLINGWORTH, *Professor of Entomology, College of Hawaii, Honolulu*

This insect has habits somewhat closely related to the well-known black carpet beetle (*Attagenus piceus* Ol.) of the United States. My first experience with this pest was upon opening up two trunks, which had been stored for about a year. After arrival in Hawaii we had packed away all of our winter clothing, which was superfluous in a tropical climate, but which we thought might be useful if we ever again visited colder regions. It was certainly a most distressing sight that met our gaze, when the trunks were opened—everything of animal origin was ruined. Our new woolen undersuits were completely riddled; fur, hair and feathers were a mass of fragments; and, worst of all, our heavy, outer clothing was shot full of holes.

I soon discovered that the beetles had not confined their attention to the trunks, for several other objects in the same storeroom were injured. A saddle, padded with sheep-skin, was badly eaten; and even the felt paper, which lined one of my small grips, was almost completely gnawed away. We soon began to find the beetles on the windows in the rest of the house, and occasionally noticed a beginning of their work in the closets. Fortunately, however, they do not give any trouble to clothing or other objects which are used frequently.

During subsequent investigations, I have found that this beetle is often destructive to dried fish in the Honolulu markets, though the principal injury to this product is by the larger dermestid, commonly known in the United States, as the leather beetle (*Dermestes vulpinus* Fab.). Dealers in brushes in Hawaii have also come to know this

pest, for it is frequently closely associated with the buffalo carpet beetle (*Anthrenus scrophulariœ* Linn.) in the destruction of their finest goods. I, also, discovered an interesting relation of these insects to the nesting of the English sparrows. Where these birds are in the habit of nesting on banks or in buildings the beetles are attracted to the masses of feathers and other animal matter used in the nest construction.

Distribution and History

Apparently these beetles have not been found outside the Hawaiian Islands, though they are pretty well distributed within the group. We have a number of records of specimens taken on Maui and Hawaii, and they are certainly abundant on Oahu,—probably a little investigation will disclose them on all the islands, for they are an insect easily transferred in shipping.

The earliest record that we have been able to locate is the description of this beetle by Sharp[1] in which he gives the note "Found in Houses in Honolulu." We are surprised, after observing the depredations of this pest, that more references to it can not be located.

Life-History

A study of the life-history was comparatively easy, since the several stages advanced so rapidly under our tropical conditions. In one instance the whole life cycle required only 150 days. It is interesting to compare this record with that of the closely related *Attagenus piceus* of the United States, which Chittenden found took two years for its development from egg to beetle.

Newly-emerged beetles were confined in a glass dish and supplied with some of the woolen cloth, which had been injured by the larvæ. A number of dead roaches and flies were also placed in the dish to insure sufficient food. After twelve days, mating was observed, but it was thirty-six days before the first eggs and newly hatched larvæ were discovered.

Egg.—The creamy-white of the eggs made it difficult to discover them on the cloth which was the same color, but after they were once observed it was rather easy to locate them with a lens. It was found that newly-laid eggs required an incubation period of about three days. In form the eggs are broadly oval; being about 1 mm. wide by 2 mm. long; the shape varying considerably, since they are rather soft.

Larva.—The newly hatched larvæ are noticeably large, compared with the eggs from which they emerge: see Figure 18, 1 and 2, which are drawn to the same scale.

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[1] Trans. Royal Dublin Soc., vol. III, ser. II, 1885, p. 147.

The larvæ were supplied with the same kind of food as noted above for the adults. They showed a great fondness for dried insects, but in no case were they observed to eat their own cast skins, even when no other food was supplied them. Pupæ, however, were sometimes eaten if left in the same dish with the larvæ.

As is common with all Dermestids, there is great variation in the larval period. While the majority run through rather close together, there are always a few, which for some unaccountable reason, are exceedingly slow, even when all observable conditions are the same. Typical development may be stated as follows: First instar, 10 to 12 days; second instar, 16 to 18 days; third instar, 14 to 16 days; fourth instar, 15 to 35 days; fifth instar, 12 to 15 days; sixth instar, 17 to 25 days; seventh instar, 33 to 46 days. It is interesting to compare with this a specimen, almost full grown when taken from the trunk a year ago. It has hardly increased in size, though abundantly supplied with food; and has molted five times, at the following intervals; 47–37–74–68–87 days. Another individual, after feeding for two years upon dried insects, and molting fifteen times, showed no growth.

Pupa.—Pupation takes place wherever the larvæ are feeding,—the last larvæ skin being shed. The pupal stage lasts from 12 to 14 days.

Adult.—The beetles, apparently feed upon the same substances as the larvæ, for our specimens reproduced abundantly and lived for a period of 40 to 52 days. As is characteristic of Dermestids, they are able to live, generation after generation, without a sign of moisture, upon absolutely dry food material, and apparently do well even when sealed up away from the air.

TECHNICAL DESCRIPTION

The Larva.—No description of this stage has been published. Figure 3 shows the general appearance of a full-grown larva. The ground color is very dark brown, and the vestiture slightly lighter. The dorsal surface is covered with short, appressed hairs, and very sparsely interspersed with coarser erect hair arranged in a transverse row along the caudal border of each segment. The lateral tufts of the thorax are slightly denser than on abdomen, where the few hairs are somewhat longer; the caudal segment terminates in a pencil of long, delicate hairs of somewhat lighter shade. Compact, suberect hairs of head, and the legs rufus. The ventral surface is whitish, the abdominal region covered with blackish, appressed hairs, denser on the terminal segments. Length of full grown larvæ about 10 mm.

The Pupa.—No description has been given of this stage either, though the pupa, which is creamy white, and covered with a fulvous pubescens, resembles rather closely that of *Attagenus piceus*. The same peculiar openings are located along the medium dorsal region of the abdomen. (See Figure 18, 3 and 4.) Each of these openings is bordered by two chitinous plates, the cephalic one bearing minute teeth. The function of these openings is hard to determine, though it has been observed that the margins will quickly close upon and grip any object inserted into them. Pupa somewhat longer than adult, measuring 6 mm.

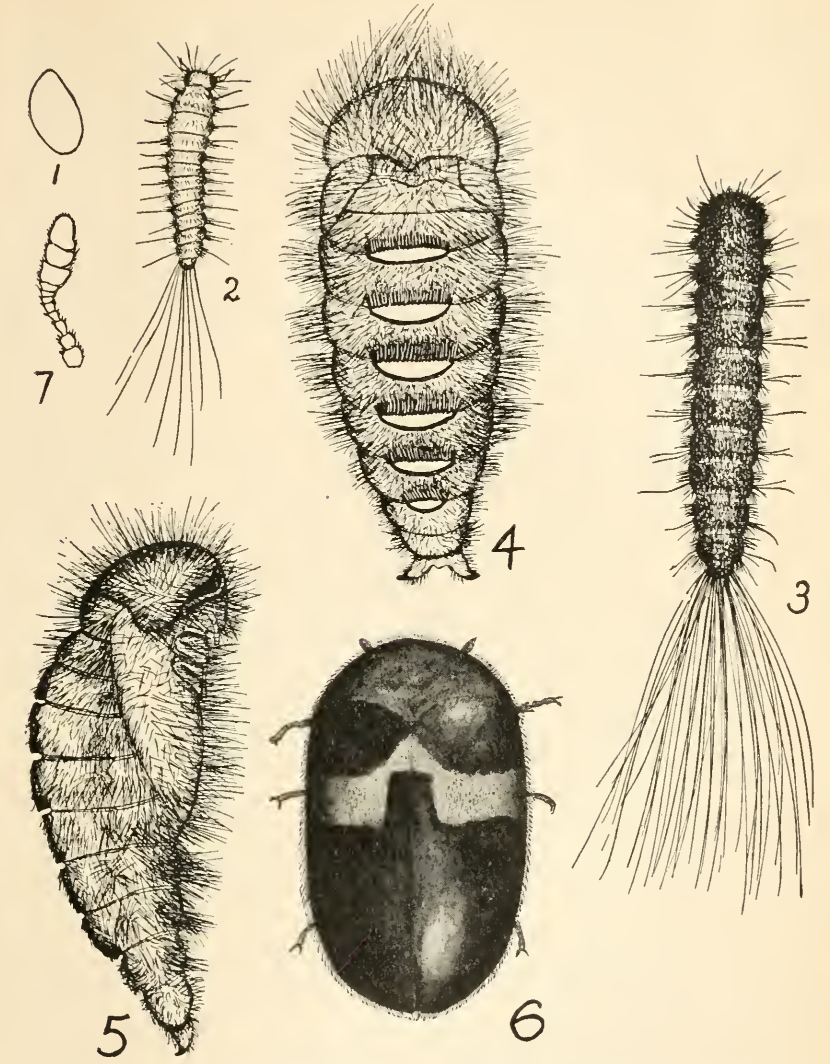

Fig. 18. *Attagenus plebius*. 1. Egg, x14. 2. Newly hatched larva x14. 3. Full grown larva, x10. 4. Dorsal view of the Pupa, x10. 5. Lateral view of Pupa, x10. Dorsal view of beetle, x10. 7. Antenna.

THE BEETLE.—It may be well to quote here from the original description since that publication is not easily accessible.

"Sat elongatus, opacus, dense pubescens, niger, antennis pedibusque rufis, capite, thorace, elytrorumque fascia angusta, angulata, subbasali pubescentiæ pallidæ. Long. 4–4½ mm. ♀♀"

"Similar in size, form, and appearance to the European *A. verbasci*, but with only one pale band on the elytra. The specimens described are probably of the female sex, and have the antennæ short, the club three-jointed, and in length equal to the

five or six preceding joints together; the apical joint but little longer than the tenth; thorax densely pubescent, so that its punctation is concealed; the pubescence pale, but in certain light, appearing dark on middle parts, owing apparently to an admixture of spots or patches of black pubescence; elytra not quite so densely pubescent as the thorax; the pubescence black, but there is a conspicuous band of cinereous pubescence near the base which at the suture is strongly angulated in front, so as to approach rather near to the scutellum; legs entirely red."

Relation to Light

Both the larvæ and the mating beetles show a decided negative relation to light. The latter, however, fly to the windows after ovipositing. The beetles may be collected in this way but it is of little avail, since the eggs have already been deposited in closets or trunks, etc.

Control Measures

Carbon bisulphide was found to be effective for the destruction of both beetles and larvæ in the trunks, but apparently the eggs were not killed by it, for young larvæ were discovered on some of the contents two weeks later. After a second treatment with the carbon bisulphide we found no further signs of the insects. To insure the contents against further attack they were given a liberal supply of flake naphthaline, scattered between the various garments. This treatment lasts for a year or more if the trunks are not opened, and no beetles will enter while the naphthaline is present.

Treatment of clothing in closets of open houses, such as we have in the tropics, is a more difficult matter. Fumigation is often out of the question, and if moth-balls are used they require frequent renewal. Fortunately, however, the clothing which is used frequently is not subject to injury. Very satisfactory moth-proof bags are on the market, and these come in such sizes that entire garments may be suspended in them.

This paper was discussed by A. W. Morrill, R. W. Doane, E. O. Essig and others.

Chairman A. W. Morrill: The next paper by Mr. G. F. Mozenette will be read by the secretary.

THE CYCLAMEN MITE, TARSONEMUS PALLIDUS BANKS, AND METHODS FOR ITS CONTROL

By G. F. Mozenette, *Corvallis, Oregon*

(Paper withdrawn for publication elsewhere)

Chairman A. W. Morrill: The next paper, by Prof. A. L. Lovett, will be read by the secretary.

ARSENIC AS AN INSECTICIDE

By A. L. Lovett, *Entomologist*, and R. H. Robinson, *Assistant Chemist, Oregon Agricultural Experiment Station*

From the standpoint of physical chemistry, it is generally known that many solid materials have the power of adsorbing certain ions from solutions. By the use of the term "adsorption" we mean the existence of a difference in the concentration of a film surrounding a solid and the concentration of the liquid which bathes this solid. In other words, the solid has a high retaining power for the material in solution. Since, therefore, it is the arsenic of the arsenical sprays that is the active element, if some inert material could be easily obtained in considerable quantities at a reasonable cost, which would adsorb sufficient arsenic to make the substance efficient as a spray, it would be worthy of consideration as an insecticide.

Acting on this hypothesis, a series of experiments were outlined, using lamp black and fuller's earth as adsorbants of arsenic from a water solution of arsenic acid. No determination of the amount of arsenic adsorbed by the lamp black and fuller's earth was made, but water solutions of arsenic acid were prepared from the chemically pure arsenic oxide and to various solutions of different concentrations of arsenic, the carbon black and fuller's earth were added as indicated in the tables. The materials were tested first as to their toxicity for insects, second for burn on apple foliage in the field.

Experiment A

April 9, 1916. Uniform samples of clean, unsprayed apple foliage were used. These were placed in large vials of water in the laboratory and thoroughly and uniformly covered with the spray solution. The foliage was allowed to dry for a period of six hours, after applying the spray, and approximately 500 small tent caterpillars (*M. pluvialis*) were introduced on each.

The materials were prepared according to the following proportions:

No. 1. As_2O_5 at the rate of 5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 5 grams to 300 c.c. H_2O.

No. 2. As_2O_5 at the rate of 5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 5 grams to 300 c.c H_2O.

The foliage of No. 1 was absolutely covered with a thick, heavy coat of black. The caterpillars were restless and dissatisfied, and piled up and suspended themselves from the foliage by webs. Eventually they covered over most of the foliage closely with a fine web. The worms on No. 2 seemed more contented.

But little, if any feeding took place for the first 12 hours; from that time on feeding was general, but restricted. On the morning of April 11, a period of 48 hours, practically all the caterpillars were dead. The amount of foliage devoured was about equal on the two materials and comparatively slight on either. The foliage showed small scattering spots of burn. By April 13, four days after spraying, the foliage on both No. 1 and No. 2 was burned to a crisp.

Experiment B

May 6, 1916. Sprayed apple foliage in laboratory with the following materials, allowed to dry and introduced approximately 1,000 half-grown caterpillars on each.

No. 1. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 2 grams to 300 c.c H_2O.
No. 2. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 1 gram to 300 c.c. H_2O.
No. 3. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 2 grams to 300 c.c. H_2O.
No. 4. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 1 gram to 300 c.c. H_2O.

As in Experiment A, the caterpillars were restless and refused to eat for a few hours, but soon commenced to feed sparingly.

Table Showing Rate of Kill of Materials

Material	Number Dead			
	May 7	May 8	May 9	Total
No. 1	40	252	454	746
No. 2	21	232	373	626
No. 3	37	531	Practically all dead	568
No. 4	24	259	257	540

Comparatively speaking, but little foliage was devoured. Most of the caterpillars which remained on the foliage were decidedly sick by the morning of May 8, and there was no feeding on the 9th. A number of caterpillars from each series dropped from the foliage without feeding and crawled away, which accounts for the small totals compared with the numbers introduced. The foliage showed small scattered spots of burn the afternoon of May 8. May 10, the burn had spread somewhat, though by no means as general as in Experiment A.

These materials might be termed rapid killers; in comparison with acid lead arsenate and calcium arsenate they apparently have a higher toxicity.[1] However, at these dilutions there is too severe a burn for field use.

[1]Lead arsenate and calcium arsenate tests for toxicity were carried on at the same time.

Experiment C.—Test of Materials in the Field

June 8, 1916. Sprayed the foliage of young apple trees in the field; foliage was thoroughly saturated with the different materials. The test was for burning only, as caterpillars were not available in sufficient numbers to warrant a check being made.

No. 1. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 2 grams to 300 c.c. H_2O.
No. 2. As_2O_5 at the rate of 1 gram to 1000 c.c. H_2O, plus lamp black at the rate of 1 gram to 300 c.c. H_2O.
No. 3. As_2O_5 at the rate of .75 gram to 1000 c.c. H_2O, plus lamp black at the rate of 2 grams to 300 c.c. H_2O.
No. 4. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 2 grams to 300 c.c. H_2O.
No. 5. As_2O_5 at the rate of 1 gram to 1000 c.c. H_2O, plus fuller's earth at the rate of 1 gram to 300 c.c. H_2O.
No. 6. As_2O_5 at the rate of .75 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 2 grams to 300 c.c. H_2O.
No. 7. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O.
No. 8. As_2O_5 at the rate of .75 gram to 1000 c.c. H_2O.

Report on burn; weather throughout fairly cool and cloudy, with showers.

June 10. Forty-eight hours after applying spray:

Lamp Black Series	No. 1. Burn general and severe.
	No. 2. Burn general and severe, though probably a little less intense than No. 1.
	No. 3. Burn general.
Fuller's Earth Series	No. 4. Burn general, though scattered and not particularly severe.
	No. 5. Burn slight.
	No. 6. Burn negligible, only trace.
	No. 7. Burn general, fairly severe.
	No. 8. Burn same appearance and about equal to No. 4.

June 11. Three days after spraying:

Lamp Black Series	No. 1. Burn spreading, very bad.
	No. 2. Burn spreading, severe.
	No. 3. Burn spreading, severe.
Fuller's Earth Series	No. 4. Slightly worse than yesterday.
	No. 5. Same as yesterday.
	No. 6. Same as yesterday.
	No. 7. Burn increasing.
	No. 8. Burn increasing.

June 24. Sixteen days after spraying:

Lamp Black Series	No. 1. Foliage burned until about all has dropped.
	No. 2. Foliage burned until about all has dropped.
	No. 3. Foliage burned, very bad.

Fuller's Earth Series:
- No. 4. Burn about same as on June 11, while probably too pronounced for general spray work, is not really serious.
- No. 5. Slightly more than on 11th, but not really bad.
- No. 6. O. K., burn comparatively slight.

No. 7. Burnt to a crisp.
No. 8. Burnt to a crisp.

Conclusions

Under field conditions lamp black is not practical, the black color probably absorbs heat and increases the burn. That the presence of an adsorbant has possibilities is clearly shown in a comparative study of the burn between Nos. 5 and 7, and between Nos. 6 and 8. Nos. 5 and 6, having fuller's earth as an adsorbent, giving comparatively little burn. Nos. 7 and 8, with the same dilution of arsenic, but without an adsorbent, burned all the foliage absolutely to a crisp. Conclusions based on one season's observations, both as to toxicity for insects and as to amount of burn indicate that there are possibilities in the use of adsorbents with arsenic and further trials are planned on a larger scale for the coming season. Estimates based on insufficient data would indicate that if such a material may be used commercially it will reduce the cost of arsenical sprays about two-fifths.

Meeting adjourned until 2 p. m. the following day.

Meeting called to order by Chairman A. W. Morrill at 2 p. m., Friday, April 6, 1917.

Chairman A. W. Morrill: The first on the program is a symposium on mail shipments of plants and plant products. This will be opened by myself and then a general discussion will follow.

Chairman Morrill: I have long held the view that postal shipments are proportionally more dangerous as regards the transmission of all plant pests than shipments by express or freight. The results of the first year's experience of parcel post shipments in Arizona tend to confirm this view. Altogether we inspected 543 of these shipments and found that 4.4 per cent contained infested or diseased plants. During the same period 2,432 freight and express shipments of plants were inspected with the result that only 2.5 per cent were found to contain infested or diseased plants. The pests found in parcel post shipments were fully as important on the average as the pests found in freight and express shipments. During the nine months' inspection of parcel post shipments the following pests were found by our inspectors: Soft brown scale (*Coccus hesperidum*) 1 shipment; purple scale (*Lepidosaphes beckii*) 1 shipment; rose scale (*Aulacaspis rosae*) 1 shipment; undetermined scales (immature) 3 shipments; plant lice

(undetermined) 6 shipments; thrips (undetermined) 3 shipments; red spider (*Tetranychus bimaculatus*) 4 shipments; citrus white fly (*Dialeurodes citri*) 2 shipments; moth larva (undetermined) 1 shipment; tortoise shell beetle larvæ on sweet potato (Cassida sp.) 1 shipment; crown gall (*Bacterium tumefaciens*) 3 shipments.

One parcel post shipment contained citrus trees from a section against which a quarantine is maintained and one contained currants and gooseberries from the district covered by the Federal Horticultural Board's request to nurseries dated March 22, 1916, to discontinue shipments into certain Western territory owing to the danger of transmitting white pine blister rust.

I am particularly apprehensive of the danger of the pink bollworm of cotton becoming established in this country and afterwards spread beyond hope of eradication by means of parcel post shipments of cottonseed. I have reason to believe that a good many plant shipments coming into the State of Arizona by parcel post have not been held for inspection by the postmasters. The particular difficulty in maintaining an efficient inspection service for parcel post shipments of plants lies in the lack of personal responsibility of the postoffice employees for the packages which pass through their hands. It has been our experience that whenever any unnecessary delay in delivery after inspection or failure to hold a plant shipment for inspection comes to our attention, it is impossible to place the responsibility among the postoffice employees at the offices concerned. Freight and express shipments however are all handled in such a manner that it is almost invariably possible to trace the blame for irregularities to the proper sources. I believe that parcel post shipments of plants are extremely dangerous to the fruit growing and farming interests of the country and I hope that the time will soon come when all shipments of plants by parcel post will be prohibited as has already been done with respect to mail importations from foreign countries.

The discussion following was general and nearly every member present participated.

Chairman A. W. Morrill: The next paper will be read by W. M. Davidson.

The Division of Entomology, North Carolina Department of Agriculture, has entered into agreement with the Bureau of Plant Industry whereby it is planned to employ a man, suitable to both parties, for one or more months' scouting work in the white pine region of the state in search of the pine blister rust disease,—this to be supplemented by special attention to five-leaved pines and Ribes in the nursery inspection work the coming summer. The blister rust disease is not now known to be present in North Carolina.

THE REDDISH-BROWN PLUM APHIS (RHOPALOSIPHUM NYMPHEÆ LINN.)[1]

By W. M. Davidson, *Deciduous Fruit Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture, Sacramento, Cal.*

Distributed in many of the plum and prune districts of California is a plump reddish-brown aphid. This aphis is generally confined to a few trees in an orchard and occasionally infests apricots and almonds. It attacks plums of the *domestica* type along with the Mealy Plum Aphis (*Hyalopterus arundinis* Fabr.), and those of the Asiatic type along with *Aphis cardui* L. In the East it also occasionally infests peaches.

The insect is apparently of European origin and was known to Linnæus. Well-known to later European and American entomologists, it has been recorded from many parts of Europe and from Maine, New York, Maryland, District of Columbia, Virginia, Pennsylvania, Nebraska, Illinois, Iowa, Colorado and California and is probably distributed throughout the United States. It also occurs in Ontario and Japan.

The species is of especial interest in that it is double-hosted, spending the winter and spring on fruit trees and the summer and early fall on a large variety of water plants, leading on them a semi-aquatic existence. In California summer forms have been recorded from *Polygonum*, *Typha*, and an unidentified pondweed, elsewhere they have occurred among others on water-lily (*Nymphea*), pondweed (*Potamogeton*), Calla and water-plantain (*Alisma*).

Biology and Habits

The stem mothers hatch from winter eggs unusually early in the season, sometimes before the buds of the trees perceptibly swell. In 1916 at Walnut Creek, Cal., hatching began about February 10, on Myrobalan plums, and the earliest aphids matured before February 26. The year following at Sacramento eggs hatched as early as February 15 on seedlings whose buds were swelling, and the aphids matured March 6. Hatching on French prunes occurs at about the time the buds swell perceptibly, the early stem mothers maturing at the time of full bloom. Eggs continue to hatch for two or three weeks, the young stem mothers exhibiting a gregarious tendency. The second generation aphids mature about as early as the stem mothers of the Mealy Plum Aphis (*Hyalopterus arundinis* Fabr.), roughly between March 20 and April 15. The spring forms feed chiefly on the tender

[1] Published with the permission of the Secretary of Agriculture.

stems, and later on the leaf and fruit petioles and during April multiply rapidly. Winged forms appear first the second week in April and may be found until July. The colonies decline throughout May and June, both through the production of winged migrants and through the increasing activity of natural enemies.

Summer colonies are found from May to October and are often very large, the individuals being very prolific. Natural enemies again exact heavy toll.

Fall migrants are produced from the middle of October to early December, the majority during the first half of this period. In 1915 at Walnut Creek, Cal., these began to arrive on the winter host October 25, in the following year on October 20. The fall migrants feed on twigs and petioles and deposit the sexed females. Winged males arrive while the females are growing and settle down on the twigs beside them. After a development period of about 20 days the females mature, copulation occurs and shortly after the females place winter eggs in the axils of the buds of the following year. The egg is rather elongate, bare, at first shining green, in a few days turning jet black.

This aphis is preëminently a twig-feeder and the fact that the stem mothers hatch so early and feed exposed points to an easy control should the species ever become of sufficient economic importance to warrant combative measures. Even on many of the summer hosts the twigs and flower stalks are preferred to the leaves.

Recognition Characters

General Color.—Reddish-brown varying to dark olive and dark greenish-brown. Newly-hatched stem mothers are green, soon changing to a dark slate-colored hue, lightly dusted with gray pruinose meal. Aphids of the second generation are yellowish-brown when born, reddish-brown in later stages. Sexual females crimson.

The head and abdomen of the pupa bear white pulverulence.

In the winged forms the head, thoracic lobes, scutellum and sterna are shining black, prothorax brown with yellowish sutures. The stigma and insertions of the wings are yellowish gray, the veins brown; the first and second discoidals thicker than the other veins. Many individuals have a series of lateral sub-circular brown areas, and besides these the males have brown cross-bands on the abdomen.

The base of the third antennal joint, basal beak joints, extreme base of femora, basal half to three quarters of tibiæ are yellowish-gray, elsewhere the appendages are dark gray, dark brown or black. Cauda gray, cornicles brownish-black with base paler.

Structure.—Antennæ placed on short frontal tubercles, shorter than the body (except in the male); joint III about four-fifths as long as the spur of joint VI, but in some instances III is but three-fifths as long as spur and again they are sub-equal; in apterous forms there are no sensoria except the usual terminal on joints V and VI; in the winged spring migrants joint III has from 17 to 22 circular sensoria distributed almost the whole length of the joint and joint IV has from 0 to 3 circular sensoria. In the winged fall migrant the number of sensoria on joint IV varies from 2 to 11, the usual number being 3. The male antenna bears on joint III about 30, on IV about

16, and on V about 12 small circular sensoria arranged irregularly; joint VI having only the usual "terminal" group. The oviparous female bears on her thickened hind tibiæ numerous small circular sensoria.

The beak reaches to or a little beyond the third coxæ. The stigma of the fore-wings is rather elongate, the stigmal vein with a shallow basal curve thence continued almost in a straight line to the margin of the wing. The cornicles are imbricated and club-shaped, constricted about basal third and again less markedly close to the apex, their shape differing according to the form, those of the spring wingless and oviparous female being less clubbed than in the other forms. The cauda is upturned in nature, about two-fifths as long as the cornicles, its apical portion quite noticeably narrowed.

A normal armature of hairs is found in all forms.

Lateral tubercles are present on the pro-thorax in all forms; on abdominal segments 1 to 7 inclusive in the winged, on abdominal segments 1 and 7 only in the wingless forms.

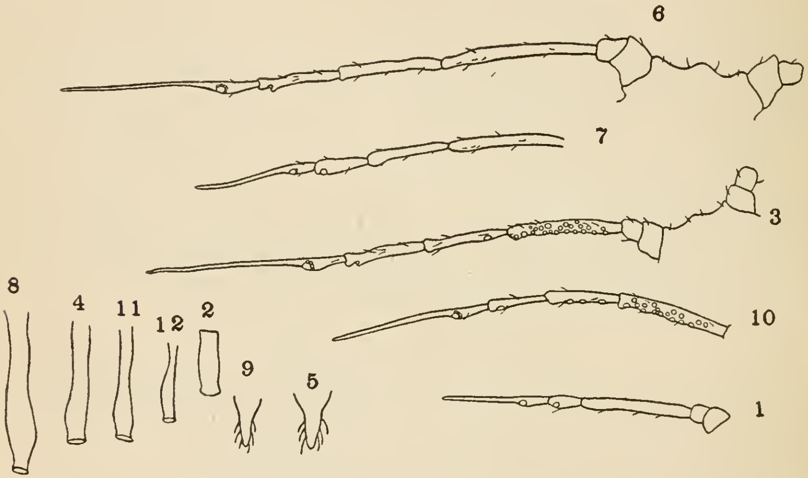

Fig. 19. *Rhopalosiphum nymphеæ* Linn.: Fig. 1, stem mother, antenna; 2, stem mother, cornicle; 3, spring migrant, head and antenna; 4, spring migrant, cornicle; 5, spring migrant, style (cauda); 6, summer apterous, head and antenna; 7, summer apterous, antenna (apical segments) from smaller individual; 8, summer apterous, cornicle; 9, summer apterous, style; 10, fall migrant, antenna apical segments; 11, fall migrant, cornicle; 12, male, cornicle. All drawn to same scale.

COMPARATIVE MEASUREMENTS (MM.)

Form	Antennæ lengths						Cornicles length	Cauda length	Beak length	Wing length
	III	IV	V		VI					
			base	spur	base	spur				
Stem mother	*.30 to .33	.095 to .105	.08 to .10	.20 to .23			.20 to .22	.13 to .15	.52	—
Spring apterous generation (Plum)...	.30	.18 to .225	.145 to .195		.095 to .125	.29 to .325	.29 to .32	.17 to .18	.52	—
Spring migrant.....	.33 to .44	.20 to .27	.20 to .24		.105 to .120	.38 to .46	.30 to .39	.15 to .18	.60 to .62	3.10 to 4.0
Summer apterous form (Summer hosts)	.28 to .39	.22 to .27	.18 to .22		.11 to .13	.36 to .39	.37 to .50	.15 to .17	.60 to .63	—
Fall migrant.......	.32 to .38	.22 to .29	.18 to .22		.09 to .14	.37 to .48	.30 to .37	.15	.65	3.05 to 3.4
Male.............	.33 to .39	.24 to .28	.19 to 23		.09 to .11	.38 to .46	.22 to .28	.09 to .11	.61	2.35 to 2.72

*Joint III evidently represents combined III and IV of later forms.

The discussion following was by R. W. Doane, H. E. Burke and E. O. Essig.

CHAIRMAN A. W. MORRILL: The next paper will be presented by Mr. Geo. P. Gray.

LABORATORY AND FIELD TESTS OF CALIFORNIA PETROLEUM INSECTICIDES

By GEO. P. GRAY, *Berkeley, Cal.*, and E. R. DEONG, *Davis, Cal.*

(Withdrawn for publication elsewhere)

This paper was discussed by A. W. Morrill and other members of the house.

CHAIRMAN A. W. MORRILL: The next paper will be presented by Mr. Stanley B. Freeborn.

THE RICE FIELDS AS A FACTOR IN THE CONTROL OF MALARIA

By Stanley B. Freeborn, *Instructor in Entomology, University of California*

The introduction of rice culture into the Sacramento and San Joaquin Valleys of California has called forth much comment as to its possible influence upon the increase and control of malaria which is already endemic in both valleys. Rice was first grown commercially in California in 1912 when 1,400 acres were planted at Biggs in the Sacramento Valley. The acreage has increased at the rate of over 100 per cent a year since that time until 1916 saw about 75,000 acres under cultivation. The industry is an exceedingly fortunate one owing to the fact that land rendered useless by previous cropping or unfit for other crops on account of faulty texture has been used for rice, thus adding materially to the state in wealth.

The cultivation of rice demands that the entire acreage be flooded to the depth of four or five inches with water stagnant or in a gentle current for a period varying from 145 to 160 days beginning about June first.

Theoretically, at least, these large bodies of standing water, well areated by a gradual addition of water and the presence of the growing rice, should form ideal breeding places for malaria-bearing mosquitoes. However, there is a deep grounded belief among those who deny the ability of the rice fields to produce mosquitoes, that there is an "essential something" in the rice fields that prevents mosquito breeding. This "essential something" is explained by another mystery,—the ecological factors governing the habitat of the different species of mosquitoes. Just as salmon, brook-trout, and steel-heads choose different breeding grounds, so the different species of anophelines invariably deposit their eggs in locations where a given set of determining factors are present. Some, it is true, have a wide range of selection but the majority are limited to very definite locations. For example, *A. malefactor*, a tropical anopheline, breeds almost exclusively in hollow tree trunks while *A. ludlowii* is limited to brackish or salt tide water. Again *A. febrifer*, a Philippine malaria carrier finds its ideal habitat at the edge of running streams and is seldom present in stagnant pools as is the case with our domestic anophelines. The statement that California rice fields will not furnish breeding grounds for malaria-bearing mosquitoes is based solely on the empirical application of the knowledge that in certain parts of the world, the hypersusceptible anophelines of the district do not find their natural breeding places in the rice fields.

Barber has shown that the rice areas of the Philippines are singularly free from malaria due to the fact that the typical rice field anopheline, *A. rossi*, is only a weak and somewhat doubtful carrier of malaria while the intensive carrier, *A. febrifer*, is a stream breeder whose breeding places are destroyed with the introduction of rice paddies. He follows these remarks with the statement that " . . . in some parts of the Philippines the further development of rice culture may result in the diminution of malaria."

Watson, writing of malaria conditions in the Federated Malay States, comments on the absence of malaria in the rice districts and its abundance in the hill country and suggests rice culture as an anti-malarial measure.

Kendrick, working in central India, observed that the rice districts on the broad open plains were practically free from malaria but that when shade such as that afforded at the edge of the jungles was present the species of anopheles changed and malaria was present. In all of these instances of malaria free rice districts, the anophelines present lacked the ability to transmit malaria or were relatively weak carriers.

From these findings of men who have dealt with the problem in various countries and under different conditions, the only safe deduction that can be made is the fact that each district requires separate investigation regardless of apparent similarity. The Californian problem can not be settled by Indian or Philippine investigations or even by those under way in our own southern states.

In order to determine, therefore, the relative importance of the rice field mosquitoes as a factor in malaria control, it is necessary to ascertain (1) what anophelines breed in the rice fields and the pools adjacent to and caused by them, (2) their susceptibility as malaria carriers, and (3) their relative abundance.

In the Sacramento Valley rice fields two anophelines find reasonably satisfactory breeding grounds judging from the number of larvæ taken. *Anopheles occidentalis* D. & K. and *Anopheles pseudopunctipennis* Theob. are both present in large numbers, making up about one half the mosquito population of the district. Probably 70 to 80 per cent of these two species find their breeding places in the pools attendant to the rice fields and caused by seepage, overflow and faulty water regulation. The other 20 to 30 per cent breed in the rice fields proper in the shallow water near the contour checks.

A. occidentalis is a recently named species which was previously considered to be *A. quadrimaculatus*, the principal eastern and southern malaria-carrier. Nearly a thousand specimens of *A. occidentalis* in our collection show all stages of resemblance to *A. quadrimaculatus* from those fairly well defined to those that are practically identical

with the latter. No experimental work has been done to show that *A. occidentalis* is susceptible to the parasite of malaria but since it is one of only two anophelines that are found in highly malarial districts and the other,—*A. pseudopunctipennis*, is only slightly susceptible, it seems reasonable to believe that it is the chief carrier. To this circumstantial evidence might be added the additional reminder of its close connection and perhaps synonomy with *A. quadrimaculatus*, a proven carrier of malaria in many parts of the United States.

Beyer and his associates stated that *A. quadrimaculatus* could be infected with the tertian and quartan types of malaria but not with estivo-autumnal. However, Hirshberg succeeded in infecting eight out of 48 specimens of *A. quadrimaculatus* that were allowed to feed on a volunteer suffering with the estivo-autumnal fever. Von Ezdorf, in a later paper, states conclusively that *A. quadrimaculatus* is susceptible to all three types of malaria.

A. pseudopunctipennis has always been looked upon doubtfully as a malaria carrier. Darling succeeded in infecting four out of 27 of this species with estivo-autumnal parasites, but a very small series of experiments with the parasites of the tertian and the quartan types of fever proved negative.

The apparent contradictions of the different findings regarding the infectivity of the same species of mosquito, is by no means limited to those above stated. The same type of contradictions is prevalent throughout the literature of infectivity experiments. This may be due in some cases to faulty technique, confused nomenclature, or the failure to state what type of malaria parasites were used for the experiment, for different types of malaria are carried by different species of *Anopheles*. Many times mosquitoes have been listed as non-malaria carriers on the basis of experiments with one type of malaria although they were the most important carrier of another type. Mitzmain has proved this in showing that *A. punctipennis* is a strong carrier of tertian fever but absolutely negative to estivo-autumnal. Another source of error seems to be in the failure to consider ecological factors. Some species seem capable of carrying malaria in one district while repeated attempts to infect them in other portions of the country with the same type of malaria invariably result negatively. Majoribanks states that *A. listoni* is the chief carrier in parts of Bengal and although occurring in large numbers in western India has never been found infected despite the fact that malaria is endemic there.

Considering both the circumstantial and experimental aspects of the California problem, I feel that we can safely say that in the rice districts *A. occidentalis* is the important carrier with perhaps a few scattered infections due to the agency of *A. pseudopunctipennis*.

These two mosquitoes breed in the rice fields close to the contour checks which wind about through the fields to hold the water at the different levels, their abundance depending largely on the character of the rice stand. A heavy and uniform stand of rice, growing well up to the checks, produces relatively few mosquitoes while a sparse stand with irregular growth at the checks generally breeds anophelines in large numbers. Far more important than the rice fields proper, however, are the overflow pools of surplus water. These vary in size from small wayside pools to vast water-soaked sloughs that lack the natural drainage to keep them dry. These bodies of water, both large and small, breed enormous numbers of mosquitoes and are entirely unnecessary. Careful construction of the irrigation ditches together with an intelligent and economical use of water would entirely eliminate them in a majority of cases.

The irrigation of the rice fields does not begin until May. The mosquitoes, however, begin active breeding in March and April, utilizing neglected pools of standing water. Again after the water is drawn from the rice fields in October, the mosquitoes continue to breed actively until the latter part of November, again utilizing neglected and useless pools. If, therefore, all possible breeding pools could be controlled before and after the rice season as well as the outside pools that occur as results of rice cultivation during the season, the mosquito population would be so considerably reduced that the number breeding in the rice fields proper would be almost negligible.

The best agricultural methods demand that the land used for rice and the adjacent territory be as nearly dry as possible before the crop is planted. Again the irrigating water should be on the fields only just long enough to mature the crop. As the rice approaches maturity every detail should be undertaken to ensure immediate drainage away from the fields at the moment that the crop matures. The fields should then remain dry until they are naturally irrigated by the winter rains. Thus it will be seen that optimum agricultural methods coincide with optimum mosquito control measures and when the industry has become scientifically standardized the mosquito question will be controlled automatically to a large extent.

Unfortunately, a large percentage of the rice cultivation is carried on by tenant farmers whose only vision is to reap the speediest and most lucrative returns. The result has been as might be expected, the irrigation ditches are badly maintained, the land is robbed of its chemical constituents by poor agricultural methods and the profligate use of water. Perhaps the most striking phase is the living conditions of the workmen. The labor is transient and many of the shelters are mere shacks lacking any attempt to exclude mosquitoes with the result

that infected laborers rapidly spread their infection throughout the district by means of the numerous mosquitoes.

The control of those mosquitoes that breed in the rice fields proper is an extremely difficult matter. Larvicides that are efficient in mosquito control, such as oil, salt, etc., are detrimental to the rice. Fish are not successful owing to the difficulty in keeping the fields stocked and their inability to feed in the shallow water inhabited by the mosquitoes. Dragonflies as adults may be looked upon as a check but not as a control. The dragonfly larvæ, even in the presence of an abundant supply of mosquito larvæ and pupæ, prefer cannabalism.

Theoretically, malaria can be controlled in two ways. If everyone in a malarial district could be cured by means of quinine treatment the mosquitoes would have no point at which to become infected or if everyone would take a daily prophylactic dose of quinine, the chances of infection even though bitten by an infected mosquito would be materially lessened and the death of the last infected mosquito would see the community free from malaria. Secondly, if all malaria-bearing mosquitoes were eliminated there would remain no transmitting agency to convey the disease from the sick to the well and again malaria would disappear from the community with the recovery of the cases infected at the time of the elimination.

Experience in different lines of preventive medicine points out the difficulty of administration of universal quinine treatment. In this country of personal liberty it would be practically impossible to force any such measure upon the people no matter how beneficial it might eventually be. On the other hand, those who have had experience with anti-mosquito campaigns know the difficulties attendant to nominal *control*, to say nothing of the *elimination* of mosquitoes from any given district.

The logical control of malaria in the rice districts of California rests in the careful application of a combination of these two methods,—zealous anti-mosquito campaigns together with careful quinine treatment or prophylaxis.

1. The rice field becomes an economic factor in the control of malaria in endemic localities when they offer breeding grounds to large numbers of anopheline mosquitoes that are capable of transmitting the malaria parasites. This is true in the California rice fields.

2. The pools of standing water outside the rice fields proper, but owing their existence to faulty agricultural methods of the rice growers, are far more important than the rice fields proper.

3. The control of breeding places outside the rice fields before, after and during the rice season combined with an application of those methods of rice cultivation that are recognized as agriculturally sound would substantially control the mosquitoes.

4. Larvicides or predaceous animals are of little use in the rice fields.
5. Organized quinine prophylaxis and treatment together with anti-mosquito precautions would decrease materially the incidence of malaria.

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Chairman A. W. Morrill: It will probably be best to wait and discuss this paper along with the next one which is to be read by Prof. W. B. Herms.

A STATE-WIDE MALARIA-MOSQUITO SURVEY OF CALIFORNIA

By William B. Herms, *Associate Professor of Parasitology, University of California, and Consulting Parasitologist, of the California State Board of Health*

The great state of California, bathed for many miles by the waters of the Pacific Ocean, favored by a semi-tropical climate, well deserves to be called the nation's health resort and playground, but while Burbank has shown how the spine-covered cactus may be made smooth to the touch, and we now have under cultivation many acres of spineless cactus, there still thrives in many parts of the state the festive mosquito, not yet shorn of its beak nor devoid of its ability to transmit malaria. Evidenced by letters in my possession there are some per-

sons who, cognizant of the prevailing dry summer conditions of California, would believe this state largely free from these pestiferous and noxious insects. True it is that the great valleys of California have little or no rainfall during the summer months, but this very fact implies the necessity for ample water to produce California's vast acreages of agricultural products. This water, supplied by extensive irrigation systems, is one of the important factors in the production of mosquitoes. To this must be added numerous more or less stagnant summer pools, due to our many rapidly receding creeks and streams. Furthermore, water from the melting snows of the Sierras continually flows down the mountain sides and spreads out here and there over the meadows of the foothills. Thus even though there may be little or no rainfall for several months during the summer, there is ample water and in such condition that the breeding of mosquitoes is favored. The fact that California is bounded for many miles by the Pacific Ocean adds many acres of salt marsh to its mosquito-producing areas. Thus the mosquito problem of the state involves both fresh water and salt marsh species.

That malaria has existed in California for at least sixty years is evident from the following quotation from the writings of Edwin Bryant,[1] one time alcalde of San Francisco and an extensive traveller in California in 1846–1847, viz.: "On some portions of the Sacramento and San Joaquin Rivers, where vegetation is rank and decays in the autumn, the malaria produces chills and fever, but generally the attacks are slight and yield easily to medicine" (page 452).

That mosquitoes abounded at that time is evidenced by the following quotation also from Bryant: "By this change we were relieved from the annoyance of mosquitoes, which have troubled us much during the night at our encampment." This quotation is taken from an entry made between the 3rd and 7th of September 1846 while encamped at Sutter's Fort (p. 273).

The first effort on the part of the University of California to assist in the abatement of the mosquito nuisance was made in Marin County in the vicinity of San Rafael at the request of Mrs. George T. Page of the San Rafael Improvement Club. This request is dated April 5, 1903. An investigation was made by Professor C. W. Woodworth and assistants with the result that oil was applied according to recommendations to certain salt marsh areas responsible for the trouble. This was followed by the employment of Mr. A. L. Ashman during the spring and summer of 1904 for the purpose of mosquito abatement.

In March 1904 the Burlingame (San Mateo County) Improvement

[1]Bryant, Edwin, 1848. What I saw in California. D. Appleton & Co., New York (480 pp.).

Club invited Professor Woodworth to make a similar investigation of the mosquito problem in the vicinity of Burlingame. Professor H. J. Quayle was detailed to organize and conduct the campaign. Here again the main trouble was traceable to the neighboring salt marshes. During the spring and summer of 1905 Quayle, assisted by students from the University of California, waged a systematic anti-mosquito campaign with marked success.[1] Considerable permanent corrective work was undertaken together with a systematic study of the mosquitoes of that vicinity. During the mosquito seasons of 1911 and 1912 a salt marsh mosquito campaign was conducted by the writer with the help of students in the vicinity of Bay point in Contra Costa County under the patronage of the Smith Lumber Company.

The writer first became definitely identified with the mosquito abatement problems of California in December, 1909, when he received a letter from Penryn, Placer County, requesting that an investigation be made of the malaria-mosquito situation in that vicinity. This investigation resulted in organizing a systematic campaign against mosquitoes during the spring and summer of 1910, terminating in a marked reduction of malaria, particularly in school children. This campaign deserves the distinction of being the first organized anti-malaria crusade in the state. The campaign in Penryn had hardly begun when citizens of Oroville, Butte County, requested that a similar campaign be organized there. These two campaigns are described in detail in the writer's book on "Malaria,—Cause and Control."[2]

The movement spread rapidly so that within the following two years crusades against malaria-bearing mosquitoes had been organized in a number of localities from Bakersfield in Kern County to Los Molinos in Tehama County.[3] One of the chief obstacles from the very beginning has been the matter of securing adequate funds to carry out an efficient crusade. The expenses had thus far been largely borne by a few public-spirited citizens. Hence very early in the work a plan was sought whereby funds might be secured on a more equitable basis, with the result that finally, after several failures, an act of the legislature was approved by the governor on May 29, 1915, known as the "Mosquito Abatement District Act."

This act provides for the formation, government, operation and dissolution of districts, to facilitate the extermination of mosquitoes,

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[1]Quayle, H. J., 1906. Mosquito Control. University of California Agric. Exp. Sta. Bulletin No. 178 (55 pp.).

[2]Herms, W. B., 1913. Malaria,—Cause and Control. XI+163 pp. Macmillan Company, New York.

[3]Herms, W. B., 1915. Successful Methods of Attack on Malaria in California. California State Journal of Medicine, vol. XIII, No. 5, pp. 185–189.

flies and other insects; and to provide for the assessment, levy, collection and disbursement of taxes therein. It provides that such tax must not be greater than sufficient to raise the amount estimated by the board of trustees of the district, appointed by the county supervisors, and must not be in excess of ten cents on each one hundred dollars of taxable property in such district.

The first district to be organized under the new law was the San Mateo District, the second being Marin County District No. 1, both involving salt marsh areas. These two districts are now in charge of Mr. N. M. Stover, a graduate of the University of California. A second salt marsh district has been organized in San Mateo County, known as the Pulgas District. The first inland district to be organized involving fresh water mosquitoes of the malaria-bearing type was at Bakersfield,—the Doctor Morris District. Oroville (Butte County) has a well organized district while the Los Molinos District (Tehama County) is ready for operation and Riverside (Riverside County) and Yolo County are now in process of formation.

The act makes it possible to include both incorporated and unincorporated territory or portions of both in the same district, thus protecting communities which draw their supply of mosquitoes very largely from the outskirts which may be outside the corporate limits.

Fourteen species of mosquitoes for California were listed by Quayle[1] in 1906, viz.: *Anopheles punctipennis* Say, *Anopheles maculipennis* Meig., *Anopheles franciscanus* McCr., *Psorophora ciliata* Fabr., *Ochlerotatus varipalpus* Coq., *Ochlerotatus lativittatus* Coq., *Ochlerotatus sylvestris* Theob., *Lepidoplatys squamiger* Coq., *Culex tarsalis* Coq., *Culex territans* Walk., *Culex pipiens* L., *Theobaldia annulatus* Schran., *Theobaldia incidens* Thom., and *Culiseta consobrina* Desv. At the present writing (1917) we have listed 27 species, viz.: *Anopheles punctipennis* Say, *Anopheles quadrimaculatus* Say (=*A. occidentalis* Dyar and Knab), *Anopheles pseudopunctipennis* Theob. (=*A. franciscanus* McCr.), *Aedes varipalpus* Coq. (=*Ochlerotatus varipalpus* Coq.), *Ædes onondagensis* Felt (=*Ochlerotatus lativittatus* Coq.=*Ædes quaylei* D. and K.=*Ædes curriei* Coq.), *Ædes taeniorhychus* Wied. (=*A. damnosus* Dyar), *Ædes sylvestris* (Theob.), *Ædes squamiger* (Coq.) (=*Lepidoplatys squamiger* Coq.), *Ædes vittatus* Theob., *Ædes increpitus* Dyar, *Ædes palustris* Dyar, *Ædes cataphylla* Dyar, *Ædes ventrovittus* Dyar, *Ædes hexodontus* Dyar, *Ædes tahœnsis* Dyar, *Ædes sansoni* D. and K., *Ædes pallatus* Coq., *Culex tarsalis* Coq., *Culex territans* Walk, *Culex quinquefasciatus* Say (=*C. cubensis* Dyar=*C. fatigans* Wied.), *Culex stigmatosoma* Dyar, *Culex erythrothorax* Dyar, *Culex comitatus* D.

[1]Quayle, H. J., 1906 (*loc. cit.*).

and K., *Culiseta incidens* Thom. (=*Theobaldia incidens* Thom.), *Culiseta inornatus* Will. (=*Culiseta consobrina* Desv.), *Culiseta maccrackenæ* D. and K., *Uranotænia anhydor* Dyar (from larva only at San Diego by Dyar). Three other species are doubtful for California, *Psorophora ciliata* Fabr., *Ædes calopus* Meig and *Culex pipiens* L.

Malaria in California

The extent and prevalence of malaria in California is best described by Snow[1] viz.: "The United States mortality reports show that in 1909 California had one eleventh of all the deaths from malaria in the registration area, which includes eighteen states, and ranked second in number of deaths for a single state. Indiana was first with 125 deaths, New York third (95 deaths), Ohio fourth (75 deaths), Pennsylvania fifth (50 deaths). In proportion to population California outranks all other states in this area. Within the state 66 per cent of the deaths occurred in ten counties extending in an almost unbroken chain along the base of the Sierra Nevada Mountains. The total population for these counties (1910 census) is 326,896. Malaria, therefore, causes five times as many deaths per 100,000 of population as the average for the United States registration area. In these ten counties (Shasta, Tehama, Butte, Yuba, Placer, Sacramento, Amador, San Joaquin, Fresno, Kern) the 1909 death-rate from malaria was one death to 4,400 people. A second group of ten counties (Trinity, Sutter, Yolo, Napa, Contra Costa, Calaveras, Stanislaus, Merced, Tulare, and Kings) contiguous to those of the first group shows one death to each 15,820 of population. A third group of ten counties (San Francisco, San Mateo, Alameda, Santa Clara, Santa Cruz, San Benito, Monterey, San Luis Obispo, Santa Barbara, and Los Angeles) forming a chain along the coast shows one death to each 57,614 of population. Twenty-eight, or almost 50 per cent of the counties show no malarial deaths. Excluding the counties of San Francisco and Los Angeles, there remains the fact that two thirds of the population live in counties which contributed all the deaths from malaria, while one third of the population of the state live in counties which had no malarial deaths in 1909. A further study of the distribution of malaria in California shows Butte County 15 per cent, Sacramento County 10 per cent, San Joaquin 9.8 per cent, Fresno 6.2 per cent, Shasta 5.4 per cent of the deaths of 1909. Three counties, with only one sixteenth of the total population of the state, have more than one third of all the deaths from malaria.

"If the counties bordering the Sacramento and San Joaquin valleys

[1]Snow, William F. Malaria. California State Board of Health Monthly Bulletin, pp. 276–279 (Nov., 1910).

and sending tributary streams to these two great rivers be divided by a line from the Suisun Bay to Mokelumne Peak it will be found that eleven counties to the north of this line show 50 per cent of the deaths from malaria in 1909, and thirteen counties to the south of the line show 30 per cent of the deaths from this cause. In other words, the Sacramento and San Joaquin valleys contributed 80 per cent of all the deaths from malaria within these valleys. The following figures are significant: Nine of the twenty-four counties had 75 per cent of the deaths, or 60.6 per cent of the deaths for the entire state. These nine counties fall into three groups, (1) Placer, Sacramento, San Joaquin, with 25 per cent of the deaths and a population of 136,774; (2) Butte, Tehama, Shasta, with 24 per cent of deaths and a population of 57,622; (3) Fresno, Tulare, Kern, with 11.6 per cent of deaths and 148,812 population.

"Reducing these figures to terms of 100,000 population and comparing with the United States census average of 4.8 for the entire registration area, the Butte-Tehama-Shasta area shows 46.8 deaths per 100,000 population; the Placer-Sacramento-San Joaquin area shows 20.4 deaths per 100,000; and the Fresno-Tulare-Kern area shows 8.9 deaths per 100,000 population."

The above report on malaria conditions in California is not based on endemic indexes and has consequently been regarded by some as of comparatively little value. While the writer had not undertaken a systematic study of large numbers of blood smears, enough of these had been examined both prior to and after Snow's report that he is convinced that endemic indexes would have shown the statements above quoted practically correct. As it is, control work already accomplished would alter the situation.

Meyer[1] states "We examined the blood of 272 children in Gridley (Butte County) and of 364 children in Chico (Butte County) and found a tertian infection in each place (one seventeen-year-old Japanese boy in Gridley and one nine-year-old girl in Chico)." This could not well be regarded as a representative index, the work having been done early in the season (May 17–31, 1915) and included only a portion of the school children. A very much more significant index was made by Kelley[2] at Redding (Shasta County) where an index was made in October, 1915, based on 435 blood smears taken from as many school children showed thirty-five infected or an index of 8 per cent, there being 17 cases of aestivo-autumnal, 17 cases of tertian and

[1] Meyer, Karl F. The Malaria Problem. Trans. of the Commonwealth Club of California, vol. XI, No. 1, pp. 21–26 (March, 1916).

[2] Kelley, Frank L. Endemic Index of Malaria in the Northern Sacramento Valley. Journ. of the Amer. Med. Assoc. (In press).

one quartan. For comparison the endemic malaria indexes for several states after von Ezdorf[1] are here quoted, viz.: Alabama 11.4, Arkansas 10.1, North Carolina 7.8, South Carolina 11.9, Mississippi 31.2, Virginia 9.3. No doubt the endemic index for Redding (Cal.) would have been greater but for some mosquito control work which had been instituted during the previous two or three summers.

A Systematic Mosquito Survey

During the course of the seven years preceding the summer of 1916, the writer had gained some knowledge of the mosquitoes of California because of his extensive field observations, but as yet no systematic survey of the situation had been undertaken. Anopheline surveys such as were carried out by the United States Public Health Service in certain of the southern states under the direction of von Ezdorf[2] are fundamental to successful malaria control measures.

A notable advance was made during the summer of 1916 in our knowledge of the malaria-mosquito situation in California and consequently we believe decided progress has been made in the control of malaria in the state. On February 23, 1916, in the office of the president of the California State Board of Health, the writer in conference with the president and secretary of the State Board of Health and the director of the Bureau of Communicable Diseases presented the matter of a mosquito survey as the most urgent necessity in the program for the control of malaria in the state. An estimate was given as to the probable cost, items involved, etc. After some discussion the suggestion was favorably received and on March 4, the following resolution was adopted by the State Board of Health, namely, "that the State Board of Health undertake in coöperation with the University of California, a survey of malaria and mosquitoes in California under the direction of Professor W. B. Herms, assisted by Mr. S. B. Freeborn, provided the funds of the Board will permit of the financing of the plan." It was estimated that the expense of the survey would approximate $2,150 for the first summer including cost of automobile, maintenance, hotel expenses, and general equipment, there being no charge made to the State Board for the services of either the writer or Mr. Freeborn.

Without discussing in detail the equipment used in carrying on the survey, it may be said that this consisted of many maps, including

[1]von Ezdorf, R. H., 1916. Endemic Index of Malaria in the United States. United States Public Health Service, Reprint No. 331 from Public Health Reports of March 31, 1916.

[2]von Ezdorf, R. H. Anopheline Surveys. United States Public Health Service, Reprint No. 272 from Public Health Reports of April 30, 1915.

topographic maps, collecting outfit, numerous pill boxes and vials for use as insect containers, microscope, stain, cameras, first aid outfit, etc. The automobile used in the survey was of five-passenger capacity, equipped with a good sized dunnage box. The personal effects of the party were carried in cases and bags.

Between April 13, the date on which the automobile was received, and May 10, the day on which the scheduled survey began, a number of trips were made in the San Francisco Bay region as far south as Palo Alto to study certain local mosquito conditions. On the morning of May 10, the party, consisting of the writer, Mr. Freeborn and a student driver, who also gave his services free to the state, left the campus of the University of California. The first few days of the survey were spent chiefly in the Vaca Valley working from Suisun to Winters, thence to Dixon, Davis and Woodland, where a second party consisting of a group of University of California students joined in the work of the survey. This group of students remained with us for the first six weeks of the trip and proved of considerable value in collecting and locating breeding places. From Woodland our work proceeded up the west side of the Sacramento to Orland thence to Hamilton and south to Princeton and Colusa. From Colusa we again went northerly as far as Redding, thence southerly to the east side of the Sacramento to Chico, thence to Marysville. In each instance the intervening territory was carefully studied, and several days were devoted to a study of the more important communities and their tributary settlements. From Marysville we again proceeded northward to Redding, thence to Dunsmuir, Yreka, Hornbrook over the Siskiyou Mountains to Ashland (Oregon) in order to trace the species to the extreme northern boundary of the state. From Ashland the trip was made to Klamath Falls and at once into California again through Modoc County, stopping at Alturas, thence to Susanville and to Reno (Nevada) via Doyle. Our next headquarters were at Loyalton, thence to Sierraville, Truckee and Placerville via Lake Tahoe. Our first trip closed June 23, when a few days were spent at Berkeley to replenish our equipment.

The second trip began June 27, going directly to Sacramento thence to Marysville, Oroville, Quincy, Downieville, Nevada City, Grass Valley, Auburn, Truckee, Placerville, Jackson, Sonora, Yosemite, Merced, returning to Berkeley July 23. During this trip our principal object was to ascertain conditions in the northern Sierra foothill region.

On July 26 the third trip was begun and consisted of a survey of Marin County, particularly the salt marsh problem of San Rafael and vicinity, thence to Petaluma, Sonoma, Santa Rosa, Sebastopol, Healdsburg, Cloverdale, Hopland, Lakeport, Upper Lake, Middletown,

Calistoga and the Napa Valley, thence again to Berkeley. The final trip of the season consisted of a further study of conditions from Benecia to Suisun and the Vaca Valley, thence to Napa and Santa Rosa, northward to Ukiah, Laytonville, Eureka, Crescent City, easterly to Redding via Weaverville, southerly to Williams, westerly to Ukiah via Bartlett's Springs and Lakeport. From Ukiah the homeward journey was made via Santa Rosa and Napa including a mosquito survey of Mare Island. The summer's work closed August 14. From May 10 to August 14 we had covered 6,446 miles or 7,036 miles from April 13, and 31 northern counties had been officially included in the survey. We had travelled from sea level, actually on the sandy beach of the Pacific Ocean near Crescent City, to an elevation of about 8,000 feet in the Sierra Nevada Mountains. We had encountered rain, hail, snow, storm, heat and cold, often subjected to dangers and hardships, but we had visited the home of the mosquito and had seen at first hand conditions good and bad as they actually exist.[1]

Object and Method of Survey

The object of the survey was threefold, first, *scientific*, in that an accurate knowledge of the specific occurrence and distribution of mosquitoes and malaria was desired; second, *economic* and *remedial*, in that accurate information relative to the breeding places of the Anopheline species was needed in order that definite and practical suggestions for control could be offered; and third, *educational*, in so far as literature was distributed, lectures were given, conferences were held and much personal work was done among the ranchers. The objectives of the survey defined from the very start the methods pursued in our survey. The itinerary of each trip was prepared in advance and adhered to very closely. Adult mosquitoes were easily located in their hiding places during the day, commonly under bridges, in culverts and in outhouses. By the use of cyanide bottles made of shell vials (1″ to 1½″ deep and ¾″ in diameter) representative collections were made. After collecting them they were at once placed between cotton wadding in small pill boxes, each box given a number which corresponded to a number on a map. Breeding places were then located, descriptions were made and photographs taken in many instances. Ordinarily this peculiar performance attracted attention and soon one or more individuals were being told the object of our work. Health officers and other public officials were frequently taken into the field and given lessons in the recognition of mosquito larvæ, particularly the Anophelines, and were given suggestions for control. In nearly all communities resi-

[1]Herms, W. B. Progress Report on State-wide Mosquito Survey. Calif. State Board of Health Monthly Bulletin, vol. 12, No. 4, pp. 192–196. (Oct., 1916).

dent physicians were consulted relative to the occurrence of malaria in the vicinity and blood smears were examined wherever available. Public lectures, previously scheduled, were frequently given, usually illustrated with local material. Perhaps the most noteworthy lecture given during the summer was that at Redding before the state convention of County Supervisors. This was well attended and evidently well received. Hundreds of copies of the State Board of Health Special Bulletin No. 9 on "Malaria and Mosquito Control" by the writer were distributed. In most of the seriously infested localities a house-to-house distribution was made.

Results of Survey with Comments

We now have without doubt a very complete collection of the species of mosquitoes occurring in northern California and by the time the survey is finished a unique representative collection of these insects will be at hand such as few if any of the larger states possess. The specimens are being properly mounted and a card index of localities is being prepared so that information relative to the occurrence of mosquitoes in a given locality can be quickly and accurately ascertained. Our knowledge of the geographical distribution of the Anophelines has been greatly amplified. One or more of the specimens of Anopheles was encountered in all but one northern California county, and we were able to find numerous specimens of Anophelines, also located their breeding places, at an elevation of 5,482 feet (this at Sierraville).

We are even more impressed than ever that the Anopheles mosquito as a real menace to health does not wander far from its larval habitat, and that with the discovery of Anophelines their breeding place may be located within a very few rods of this point.

The chief source of Anophelines was quite commonly the green scum-covered edges of a small receding stream, creek or irrigation ditch, or grassy weed-grown pool of clear water. While the Anopheles mosquito may breed in vile stagnant water, it prefers clear, fairly cool water such as one frequently finds in smaller streams with sandy or pebbly bed. The current may be fairly swift in one part of the stream but the edges are commonly shallow and left-over scum-covered pools occur nearby.

While the survey has revealed the fact that Anopheline mosquitoes are more widely distributed than was at first believed to be the case and that consequently the malaria menace is also greater, we are no less positive in our belief that malaria can be brought under control. It is, however, a matter of detail, intensive rather than extensive. For example, a small overlooked pool of water, originating from a tiny stream beneath a fruit-packing house, may produce ample Ano-

pheles mosquitoes to distribute malaria among the employees who may work toward evening during the rush season, or larvæ may occur in an open spring which supplies drinking water for the nearby fruit-picking camp, etc. The successful operation of malaria campaigns calls for specially trained men.

Far too little attention is paid to the irrigation ditches and methods of irrigation in northern California. Until this matter receives proper attention there will always be more or less malaria in our irrigated districts. This is further evidence that details are overlooked and that the irrigation and drainage engineer to whom such matters as mosquito control are often referred is not meeting the requirements, that he is interested in the successful operation of the work at hand and is not responsible for the water as it may prove a menace to health. This is not ordinarily within the scope of his work. That there is little or no malaria in the irrigated districts of southern California is a mere coincident in the problem of conducting water from place to place in the most economical manner.

The recent introduction of rice culture in California brings with it new problems. These were studied with some care during the progress of the survey. Rice culture is evidently most successful in regions which also favor mosquitoes. In most instances both mosquitoes and malaria have preceded rice culture in a given locality, and the introduction of rice has merely increased the number of mosquitoes and the cases of malaria. In certain sections there is strong antipathy toward the rice industry because of its effect on health and comfort, on the other hand the rice grower displays a feeling of indignation because the entire responsibility is placed on his shoulders, in spite of the fact that both mosquitoes and malaria preceded the advent of his industry.

Out of our study of the rice situation there have come several important conclusions, namely that the rice grower is guilty of carelessness and does not practice sound agricultural methods. He is intent on quick returns at a minimum expense. The irrigation systems are as a rule carelessly constructed with the result that the roadsides are bordered for miles and in some instances actually covered by water. It is this careless and profligate use of water which is responsible for the enormous increase of mosquitoes. It seems quite reasonable to believe that more than 50 per cent of the trouble will be eliminated concomitant with the practice of scientific methods in the culture of rice.

Furthermore, after the water is drained from the fields in the autumn great numbers of pools remain along the contour checks and the roadsides in which mosquitoes continue to breed for some time after the

rice harvest, and again in the spring before the fields are flooded. Therefore it is recommended that mosquito control measures be put forth with vigor both before and after the fields are flooded.

While dragonflies breed in enormous numbers in the rice field they appear too late in the larval form to reduce the mosquito larvæ and the consequent hordes of mosquitoes to any appreciable extent. If dragonfly larvæ could be produced in sufficiently large numbers very early in spring and were transplanted to the rice fields at the beginning of the season some appreciable effect might be secured.

Bat roosts in the neighborhood of rice fields have been recommended but our experience with bats does not lend a very hopeful aspect to this means of control.

That much quinine is consumed in the malarial regions of California without apparent good results is quite evident. Self-treatment with large quantities of quinine without regard to schedule is commonly practiced. Enormous sums of money are expended for quinine and sundry patent medicines,—much of it uselessly.

The winter treatment of malaria carriers in all sections where the disease occurs and proper quinine prophylaxis in districts difficult to control deserve much more attention than is at present accorded these matters.

As a direct result of the malaria-mosquito survey there will come many new organized mosquito abatement districts under the act above described, but no doubt the greatest good coming out of the work is fundamentally educational in that literally thousands of persons,—men, women and children,—were reached on their own ground and were told what malaria is, how it is carried and how to control it. In many instances the writer saw the remedy (mosquito control) applied before he left.

It is planned to complete the survey of the state during the coming summer, starting early in May at the southern border and working northward.

The two papers were generally discussed by R. W. Doane, A. W. Morrill, Earl Morris, C. W. Woodworth, E. O. Essig and others.

Chairman A. W. Morrill: The next subject will be presented by Mr. G. A. Coleman.

THE DEVELOPMENT OF THE MOTION PICTURE AND ITS PLACE IN EDUCATIONAL WORK

By GEO. A. COLEMAN, *University of California, Berkeley*

The story of the development of the motion picture camera and motion picture projectors reads like a fairy tale of romance, yet it is the story of real scientific achievement unequaled in its account of the overcoming of apparently insurmountable difficulties. For the solution of the scientific problems involved it has demanded the best talent from among European and American mechanical experts, designers and manufacturers of lenses, camera equipment, and chemists. The successful solution of these problems has only been possible through the coöperation of all.

Motion picture photography was born on the Stanford Ranch, Palo Alto, California, about 1872, when Governor Stanford was induced by Mr. Muybridge to allow him to experiment in photographing the governor's horses. The first motion pictures were made by setting up twenty-four cameras in a row facing the racetrack, each camera being equipped with an ingenious arrangement of a string and spring attached to the shutter. The horse in trotting past the cameras touched each string and so released the shutter, thus taking his own photographs, a series of snap shots. Governor Stanford rendered a real service to the science of Cinematography when he took these photographs to Paris and exhibited them, thereby gaining the attention and interest of Messioner, the great animal painter. Messioner was fascinated by them, because he was himself a great student of the curious attitudes which horses assume when in rapid motion, and had already attempted to incorporate in his paintings some of his own observations. These photographs gave him just the proof he needed to establish the correctness of his own observations with his fellow artists who were disposed to criticize his ideas and work. Indeed here we have the keynote to the use of the motion picture in scientific investigation and instruction, viz., an infallible record.

The motion picture camera has now been brought to a high state of mechanical perfection and optical efficiency. There are a number of good makes on the market. After a somewhat extended investigation of a number of foreign makes, the author has chosen the Universal camera and tripod, made in Chicago, which, equipped with a battery of lenses of from two to six inch focus, or longer if desired, makes an outfit adapted to all kinds of work afield, and will withstand the trying effects of all kinds of climate from the tropical jungle to the rigors of the arctic. (The outfit was here exhibited.)

The manufacture of motion picture films has kept pace with that of equipment, and owing to the indefatigable efforts of Mr. Eastman, we have film which will record anything the camera can take. To such perfection has the film, and the mechanical work of the camera been brought, that the taking of five hundred consecutive pictures in one tenth of a second, a thing undreamed of a few years ago, is now possible.

Here, then, we have the means of recording and reproducing for classroom and lecture room, and for careful study, all of the muscular and other movements of the vast animal and plant population of the entire globe. By means of the X-ray and the microscope, in connection with the motion picture camera, we can photograph not only the external, but the internal anatomy of every living thing upon the earth, in the air, or in the sea. When we stop to think of the vast field of investigation, of which we are just now at the threshold, we may stand in awe of the forces of nature, yet we cannot help but feel a profound respect for the powers of the human mind which has opened the door and let the general public get a glimpse of the innermost secrets which are so jealously guarded by old dame nature.

The "dry-as-dust" lecture on insect taxonomy can be enlivened now and then with a few feet of film, analyzing the "buzz" of the bee's wing, the "song of the katydid, or katydidn't," the "chir-r-p" of the cricket, the stride of "sir" beetle, and the sailing, or soaring, of "Madam Butterfly."

The insect biologist no longer needs to cover the walls with charts showing "all stages in life-history," etc., etc., or with curves, the key to which has long since been lost, for by means of the motion picture record he can get together a life-history stretching over months, or years, and present on the screen in a few minutes, the entire transformations for the eyes of the students, thus stimulating their interest to a study of the real insect life-history much more effectively than is possible with any series of dried or pickled specimens, however carefully they may be prepared.

Museum specimens have their uses, *as records*, but they also have *their limitations*, for classroom, or lecture demonstrations, besides, *it spoils the specimen.* Lantern slides were a step in advance, but too slow. The moment you introduce *motion* into your subject, your audience is fascinated, their attention riveted, and your point of instruction is driven home.

The economic entomologist need no longer fear the bugbear of classroom work, for he can now devote himself entirely to the research so dear to his heart, while an assistant merrily turns the crank of the Kinetiscope, or Pathescope, grinding out the pictures at the rate of

sixteen thousand every twenty minutes, stopping between reels to answer the stream of questions which the admiring multitudes of freshmen will certainly be stirred to ask. As for the general public,—a motor-driven machine, a few hundred thousand feet of film, covering all lines of scientific investigation, farm and orchard management, and you can take that long cherished—but seldom realized hope—a real vacation.

The following paper was read by title:

SOME COMPARISONS OF COCCUS CITRICOLA AND C. HESPERIDUM[1]

By H. J. Quayle, *University of California, Citrus Experiment Station, Riverside, California*

Coccus citricola was described as a new species in 1914.[2] For some years previous to that time, this species of scale insect was confused with *C. hesperidum* as well as with one or two other species. The identity of the two species named is still a matter of doubt with persons not familiar with them, and, in certain stages or without ample material, their identity may not be plainly evident even to those who have given the species some study. Nevertheless the species in question are quite distinct, and it is the purpose of this paper to point out some of the differences and also some of the similarities.

The most important morphological characters separating these two species of scale insects are to be found in the antennæ, both as regards the number and the relative lengths of the joints.

Hesperidum almost invariably has seven joints, while *citricola*, in the great majority of cases, has eight joints.

In seventy-eight specimens of *citricola* in which 139 antennæ were examined, there were three scales each with seven joints in one antenna and eight in the other. In four scales there were seven joints in both antennæ, and in four others there were seven joints in one antenna while the other antenna was not examined. The remaining number, or sixty-seven, had eight joints in both antennæ.

In seventy-three specimens of *hesperidum* examined all had seven joints.

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[1]Paper No. 42, University of California, Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, California.

[2]Campbell, Roy E. A new species of Coccid infesting citrus trees in California. Entomological News 25: 222–224, 1914.

In all scales examined the seventh, or usually the next to the last, joint of *citricola* was shorter than the seventh, or last, joint of *hesperidum*.

With two exceptions the fourth joint of *citricola* was shorter than the fourth joint of *hesperidum*.

Considering averages, in the majority of antennæ examined the third joint of *citricola* was shorter than the third joint of *hesperidum*.

Considering averages, the fifth joint of *citricola* was longer than the fifth joint of *hesperidum*.

Although *citricola*, usually, has one more joint than *hesperidum*, the total length of the antennæ of *hesperidum* will average longer than that of *citricola*.

C. CITRICOLA

Average length, in micrometer spaces, of antennal joints:

1	2	3	4	5	6	7	8	Total
10.0	9.05	11.88	9.80	9.73	7.56	7.43	13.14	78.59

C. HESPERIDUM

Average length, in micrometer spaces, of antennal joints:

1	2	3	4	5	6	7	8	Total
10.2	9.94	15.92	16.82	6.60	7.18	16.43	—	83.09

In *hesperidum* the number of hairs of the anal ring is usually given as eight. In the original description of *citricola* six was the number stated for this species. Upon examination of the above characters, the writer finds that there are six large and two small hairs on the anal ring of both *hesperidum* and *citricola*. The two small hairs are not readily seen without dissecting out the part and mounting so as to show all the hairs in about the same plane. While, from the observations of the writer, the number of hairs of the anal ring is the same in both species in question, the difference in their length is very marked, those of *hesperidum* being about one-fourth longer than those of *citricola*.

There appears to be no well marked distinctions between the motile larvæ of the two species. The antennæ in this stage consist of six joints. In *citricola* there is an indication of eight joints by a more or less distinct separation of the fourth and fifth into two joints each. In the second instar there are still but six joints although the cleavage into two of the fourth and fifth joints is more pronounced than in the larva. In the third instar the adult condition of eight joints is acquired. In the case of *hesperidum*, the extra joint of the adult is probably formed by the fifth joint dividing into two.

In general appearance *citricola* may be distinguished by the more even distribution of the dark color pigment and the general ground

color of gray or dirty white. *Hesperidum* has the color pigment coalesced in more or less definite areas and the ground color is distinctly yellowish. In lustre, *citricola* is dull while *hesperidum* is shiny.

Hesperidum varies in shape more than *citricola*. The former may be straight on one side and curved on the other, or otherwise different from the usual oval, particularly, if they are situated along the midrib or if the specimens are crowded closely together.

It is in their life history and habits that the two species are markedly different. In *citricola* there is but one generation a year, while in *hesperidum* there are three or four over-lapping generations. Individuals of different sizes that may be seen at any one time in the case of *hesperidum* furnish a ready means of distinguishing the two species. From August to March all living specimens of *citricola* are uniformly of small size. During May, June and July there may be two sizes of this species, either mature individuals or very small specimens. *Citricola* is oviparous while *hesperidum* is ovoviviparous. The male of *citricola* is only occasionally seen. On citrus trees the puparium of the male of the black scale (*Saissetia oleœ*) is likely to be mistaken for that of *citricola*. The puparium of *citricola* may be distinguished from that of the black scale by the broader band, consisting of numerous cross lines, bordering the coronet. There are several references that refer to the male of *hesperidum*, but in the writer's judgment the proof in these references is not sufficient to say positively that the male described was of this species. Male puparia have been taken in the midst of infestations of *hesperidum*, but in all cases observed, they proved to be that of *S. oleœ*, *L. corni* or *C. citricola*, infestations of which were in the immediate vicinity. It is not unlikely that the male of *hesperidum* occurs, but evidence of the fact in the references at hand seems insufficient.

The host plants of *hesperidum* include a very wide range in number and variety. Those of *citricola*, as far as observed, include all varieties of citrus, hackberry, *Celtis occidentalis;* buckthorn, *Rhamnus crocea;* pomegranate, *Punica granatum;* night shade, *Solanum douglassi;* English walnut, *Juglans regia;* and Elm, *Ulmus americana*. The host plants named, other than citrus, were found infested in more or less close proximity to citrus. The discovery of the scale on hackberry, some of which trees were said to have been imported from Japan, led to the suspicion that the scale may have come from that country. But in correspondence with entomologists in Japan it is learned that *C. citricola* is not known to occur there, or at least is not native to the country. Mr. C. P. Clausen writes that he has seen what he considers to be *C. citricola* on citrus in Japan, and that it probably has been introduced from California.

C. citricola was first observed on buckthorn growing in the immediate vicinity of a citrus nursery. Since the buckthorn is a native plant, growing in the mountains and in waste places in the valleys, it was thought that the origin of the scale was accounted for. Upon further exploration of different areas where buckthorn grows, it was found that infestations of the scale on this plant did not occur at any great distance from infested citrus trees. The scale was found most abundantly on buckthorn growing in immediate proximity to citrus trees. It has been found in scattering numbers on the same plant growing in the washes from Claremont to Glendora. Specimens have been taken on buckthorn in the San Dimas and San Gabriel canyons two miles from citrus trees. It was not observed on buckthorn in the vicinity of Santa Barbara or in Laurel Canyon near Hollywood, or elsewhere. Further exploration of the buckthorn may result in a different conclusion, but at present it appears that *citricola* went from the citrus to the buckthorn instead of *vice versa.*

The parasites that have been reared from both *citricola* and *hesperidum* include *Coccophagus lecanii, C. lunulatus,* and *Aphycus luteolus. Microterys flavus* is a common parasite of *hesperidum* but thus far, there appears to be no record of this species being reared from *citricola. Coccophagus flavoscutellum* has been reared from *citricola* but not from *hesperidum.* Timberlake[1] records some other parasites and hyperparasites of *hesperidum* which have not been reared from *citricola,* but less extensive studies have been made on the parasites of the latter species. It is well known, however, that *citricola* is much less subject to attack by parasites than *hesperidum.*

At the South Carolina College and Station, two laboratories in charge of Mr. G. M. Anderson have recently been established in the southern part of the state; one deals with the boll weevil problem, and the other with the American mole cricket which is developing into a serious pest, especially of truck crops, at some points along the coast. Mr. J. A. Berly, research assistant, is in charge of the temperature-moisture problem at the home laboratory, working in coöperation with the division of Southern Field Crop Insects of the Bureau of Entomology. Professor W. A. Thomas has about completed his work on the cotton root louse and at present is engaged in a special study of the Aphididæ of South Carolina, with special reference to economic control. The work of the Crop Pest Commission has developed satisfactorily during the past year. An item of particular interest is the absolutely successful control of three heavy infestations of the cottony cushion scale in Charleston by the introduction of the Vedalia lady beetle, through the courtesy of the Plant Commissioner of Florida.

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[1]Timberlake, P. H. Preliminary report of the parasites of *Coccus hesperidum* in California, Jour. Econ. Ent. 6: 293–303, 1913; and Revision of the Genus *Aphycus*, Proc. N. S. N. M. 50: 561–640, 1916.

Scientific Notes

Aleyrodes citri not in Porto Rico. In the April number of *Phytopathology*, in an article on Porto Rican plant diseases, appears the following statement: "The fungus appears to be growing upon a scale insect, probably *Aleyrodes citri*." This statement refers to a white-fly found on the undersides of the leaves of Guava, the writer assuming that it is the notorious citrus white-fly.

Aleyrodes citri Riley and Howard has never been found in Porto Rico to our knowledge. There are, however, two species of white-fly that are commonly found on Guava in Porto Rico, *Aleurothrixus howardi* Quaintance and *Aleurodicus* (*Metaleurodicus*) *minimus* Quaintance, and it is very probably one of these to which the writer refers.

Richard T. Cotton.

How the Bureau of Entomology is Meeting the Great Issue. Immediately upon receipt of the news of the Declaration of War, the following letter was transmitted by the Chief of the Bureau to each member of the Bureau of Entomology, both in Washington and in the Field Service:

April 7, 1917.

"The crisis in which this country is placed makes it necessary for the Bureau to do all it can towards the conservation of our resources. It has been decided to establish a system of reporting local outbreaks of insects so that the Bureau will have the earliest possible information regarding unusual injury to crops. This service will receive reports on insect abundance, make tabulations and maps, and compile statements for the use of the men in the field as to probable damage.

"Will you please make it a part of your duty to report promptly through your section chief all observations on insect damage which are of more than usual intensity, and report the first occurrence of well-known pests. In all cases where possible numerical estimates should be made. This work should cover all injurious insects which may come to your attention regardless of the work in which you may be regularly engaged. It is not intended, however, that this shall supplant the regular work. It should be merely incidental but at the same time carried on to as full an extent as possible without interfering with other important matters.

L. O. Howard."

The Department of Entomology of the Alabama Experiment Station is endeavoring to do its bit in the campaign for increased food supplies partly through the saving of at least $2,000,000 worth of corn that is liable to be destroyed by insect attack in the cribs during the next two or three months. Furthermore, arrangements have been made for prompt reports by demonstration agents, agriculturists in our District Agricultural Schools and others of any threatening insect occurrence in this state. An effort will be made to get these reports much earlier than they would come ordinarily from the farmers themselves, so that remedial measures may be applied in time to prevent loss.

In the Gulf States section, the winter of 1916 and 1917 has been the most severe for perhaps 18 years past. Serious damage has been done by cold to citrus fruits and figs particularly, also in a less degree to other fruit crops. Probably as a partial result of winter injury, more numerous reports are being received of injury in which some new fungus diseases and borer injury seem to be associated. Some of these attacks are occurring upon a large variety of fruit and forest trees and promise to be serious problems for future study.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1917

The editors will thankfully receive news items and other matter likely to be of interest to subcribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

Separates or reprints, if ordered when the manuscript is forwarded or the proof returned, will be supplied authors at the following rates:

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It may be well to call attention to practical limitations evident to anyone giving the matter thought and yet apparently ignored by some. Recent volumes of the Journal have contained about 600 pages and represent practically all that can be issued with present resources. There are approximately 450 members with equal opportunities for publication. It was decided some years ago, and the policy seems on the whole a wise one, that precedence should be given to the Proceedings. That decision was made before we had a Pacific Slope Branch with its summer meeting and it seemed only an extention of the earlier policy to apply it to the western gathering. The large number of papers presented at a meeting necessitated limiting the time devoted to each and some have given abstracts or portions and submitted the entire paper for publication. Considerable discretion must lie with the Editor and the above statement is made for the benefit of one who becomes impatient at delay or who looks askance at suggested condensation. Some authors have withdrawn papers because they could not be published earlier and under present conditions the Editor was powerless, so far as hastening matters is concerned. Here is a place where we must all coöperate. Adaptation will do more to help the situation than rigid regulation.

Edwards' Bibliographic Catalogue of the Described Transformations of North American Lepidoptera is favorably known to economic entomologists and, in earlier days at least, was exceedingly useful. The

great expansion of knowledge since the above-named work appeared has made aids of this character most desirable. There is a manuscript which brings this publication nearly to date; it has been completed for some time and there appears to be no immediate prospect of its being published. The usefulness of this compilation, though technical in nature and necessarily somewhat extended, is apparent to every practical entomologist and it is suggested that those appreciating such assistance should interest themselves in this matter. The work would, in an indirect manner at least, be extremely helpful to an extended clientage, since the efficiency of the entomologist is greatly increased if he can have at hand a volume which will quickly and surely put him in touch with all available information concerning the Lepidoptera—a group comprising many of our most important and destructive pests.

Current Notes

Conducted by the Associate Editor

Mr. C. H. Cale has been appointed to take charge of the apicultural work at the Maryland State College of Agriculture at College Park, Md.

Mr. George G. Schweis, formerly assistant entomologist in the Nevada Agricultural Experiment Station, has been appointed state apiary inspector for the state of Nevada.

The following resignations from the Bureau of Entomology are announced: George H. Rea, to accept an appointment at Harrisburg, Pa.; Mr. Neuls, Alhambra, Calif., to go into business.

The legislature of Minnesota has passed a law authorizing the state entomologist to control the pine blister rust and appropriating $15,000 for the next two years for this purpose.

Mr. W. R. Walton of the Bureau of Entomology has been placed in charge of Cereal and Forage Insect Investigations, the position formerly held by the late Professor F. M. Webster.

Professor C. L. Metcalf of Ohio State University is to return about June 10 for the summer, to the Maine Agricultural Experiment Station for a continuation of his Syrphid studies.

According to *Science*, the Rev. O. Pickard-Cambridge, F. R. S., author of works on arachnology, entomology, and general natural history, died on March 9, at the age of eighty-eight years.

Mr. W. J. Chamberlin, assistant in Forest Entomology at the Oregon Experiment Station, has been granted an indefinite leave of absence to enter the Officers' Reserve Corps training camp in California.

Mr. Marion Wadley, a graduate student of the Kansas State Agricultural College, has accepted a position in the Division of Truck Crop and Stored Product Insect Investigations of the Bureau of Entomology.

Professor W. C. O'Kane, Durham, N. H., and Harold L. Bailey, Bradford, Vt., were among the entomologists attending the hearing regarding the white pine blister rust, held before the Federal Horticultural Board at Washington, D. C., April 10.

Mr. William C. Woods will be a member of the summer staff at the Maine Agricultural Experiment Station for the summer of 1917. He will be engaged with "Emergency Entomology" and special work with Chrysomelid beetles.

Mr. August Busck of the Bureau of Entomology recently visited Mexico, in the region of Monterey, San Pedro and Torreon, where Egyptian cotton has been planted, to study the extent of the pink bollworm infestation.

Mr. H. M. Parshley of the Bussey Institution, Harvard University, has accepted an appointment as assistant professor of Zoölogy at Smith College, Northampton, Mass., and will begin his duties with the next college year in September.

Mr. H. J. Reinhard, assistant entomologist of the Texas Station, is completing extensive studies on the artificial control of the cowpea weevil, *Bruchus quadrimaculatus* Fabr. Special attention has been given to heat as a means of control.

Professor Franklin Sherman, Jr., was appointed to represent the American Entomological Society at the inauguration of Wallace Carl Riddick as president of the North Carolina College of Agriculture, Raleigh, N. C., on February 22, 1917.

Professor Charles T. Brues of Bussey Institution, Forest Hills, Mass., Mr. Harold L. Bailey of Bradford, Vt., and Mr. James A. Hyslop of the Bureau of Entomology, stationed at Hagerstown, Md., recently visited the Connecticut Station at New Haven.

Dr. C. Gordon Hewitt, Dominion Entomologist of Canada, has also recently been appointed consulting zoölogist by the Canadian government, and will advise in matters relating to the protection of birds and mammals and the treatment of noxious species.

Mr. S. C. Clapp, assistant in Entomology, North Carolina State Department of Agriculture for nine years, has been appointed superintendent of the Mountain Station of the Experiment Station and State Department of Agriculture at Swannanoa, N. C., and entered on his new duties in February.

Very interesting but rather unexpected results are being obtained in the exhaustive artificial migration tests with the cotton or melon louse, *Aphis gossypii* Glov., by F. B. Paddock, state entomologist of Texas. There are two color forms of this species which complicates the migration tests.

At the annual meeting of the National Academy of Sciences convened April 16 and adjourned April 18, Mr. W. V. King, of the Bureau of Entomology, introduced by Dr. L. O. Howard, presented a paper entitled, "Sporogony of Malaria Parasites," with photomicrographs of infected *Anopheles*.

At the present time beekeeping is taught in the agricultural colleges in twenty-two states. In all but one or two cases this work has been inaugurated within the past five years. In ten of these colleges, the work occupies the exclusive attention of at least one instructor.

Mr. I. M. Hawley (Ph.D. Cornell) has been appointed assistant in the Division of Entomology, State Department of Agriculture, Raleigh, N. C., and began work in February. He succeeds Mr. S. C. Clapp. He will be responsible for much of the inspection work, and will also undertake some investigation projects.

Mr. C. H. Popenoe of the Bureau of Entomology has recently returned from a trip to Philadelphia for the purpose of inaugurating a fumigation of baled furs by the vacuum system. The John B. Stetson Company has recently installed a plant capable of a capacity of 50–1200 pound bales of fur per day.

Provision has been made to repeat the vacuum fumigation tests with pink bollworm larvæ under the direction of Mr. E. R. Sasscer of the Federal Horticultural Board to confirm results obtained in the earlier experiments, and also to determine the effect on these larvæ of the residual gas remaining in cotton bales. The living material for these tests was obtained from Hawaii through Mr. C. E. Pemberton.

Mr. E. J. Vosler, who for several years has been secretary of the California State Commission of Horticulture and editor of the *Monthly Bulletin*, has recently been appointed foreign collector of beneficial insects for the Commission. Mr. George P. Weldon succeeds him as editor of the *Bulletin*, and Mr. H. S. Maddox as secretary of the Commission.

The last General Assembly of Arkansas created a State Plant Board which will henceforth have charge of all orchard and nursery inspection work, and will have headquarters at Little Rock. Professor J. Lee Hewitt, plant pathologist of the Station, has recently been appointed chief inspector, and for the time being should be addressed at Fayetteville, Ark.

The following transfers have been made in the Bureau of Entomology: E. J. Newcomer from Wenatchee, Wash., to Portland, Ore.; Alan G. Webb, Boston, Mass., to Seattle, Wash.; G. D. Smith, Thomasville, Ga., to Madison, Fla.; A. J. Ackerman, West Chester, Pa., to Benton Harbor, Mich.; Frank R. Cole, Washington, D. C., to Hood River, Ore.; C. E. Smith, Baton Rouge, La., to Muscatine, Iowa.

Dr. R. R. Parker, assistant entomologist of the Montana State Board of Entomology, will continue the study of the Rocky Mountain spotted fever tick this season and will be located in a field station at Musselshell, Montana. He will be assisted by Mr. R. W. Wells, who received the degree of Master of Science in Entomology from Montana State College this year.

Dr. G. F. White of the Bureau of Entomology, who has done much work on the bacteria of apiary diseases, has now been assigned to diseases of insects, Cereal and Forage Insect Investigations. He will give particular attention to bacterial diseases, such as wilts of larvæ, etc., and will be glad to receive specimens supposed to be attacked by bacterial or other diseases.

Mr. George H. Rea, who has been recently employed with the U. S. Bureau of Entomology, has been appointed Chief Apiary Adviser under the Pennsylvania Bureau of Economic Zoölogy, and will take immediate charge of the field work in this line. Approximately fifty demonstration meetings have been arranged for the month of May in various bee yards in thirty-three counties of the state.

Mr. C. H. Popenoe, entomological assistant, and Mr. N. F. Howard, expert on Insects as Carriers of Plant Diseases, both of the Bureau of Entomology, attended the meeting of entomologists and plant pathologists at Pittsburgh, Pa., April 16–17, to discuss plans for coöperation with the H. J. Heinz Company and state officials on the project of insects as carriers of cucurbit wilt and other diseases of truck crops.

The chief project taken up by Professor A. L. Lovett, entomologist at the Oregon Experiment Station, consists of a study of the toxic sprays for insects. The work this year will include an intensive study of spreaders for arsenate of lead, the use of calcium arsenate alone and in combination under Western Oregon conditions, and

the use of nicotine sprays and oil sprays as repellents for insects which disseminate fire blight.

Mr. W. H. Goodwin, who has been at the Ohio Experiment Station for nine and one-half years, entered upon his duties May 1 at the Pennsylvania Department of Agriculture, Bureau of Economic Zoölogy, and will be in immediate charge of the sixteen men in the field, known as "crop pest advisers." Especial emphasis is being placed this year on potato growing, with particular attention directed toward the control of pests ordinarily affecting this crop.

Dr. J. F. Illingworth, professor of Entomology, College of Hawaii, Honolulu, has been granted a leave of absence for three years, in order that he may carry on investigations for the Queensland government. He is to be located at Gordonvale, Caïrns, North Queensland, in the midst of the sugar-growing section. An experiment station is to be developed, primarily for the study of the grub-pest, which is such a scourge in certain cane-growing areas.

The Connecticut legislature has recently passed a new crop pest law applying to future emergencies, and giving the director of the Agricultural Experiment Station authority to take such measures as may seem necessary for the extermination or control of all pests. A separate measure has also passed, appropriating $15,000 for the next two years for the control of the white pine blister rust; of this, $5,000 is at once available, and work has already been started.

The Iowa legislature has recently passed a law which reorganizes the apiary inspection work of the state and unites it with the extension work in beekeeping of the State College of Agriculture and Mechanic Arts at Ames, according to the recommendations of the present inspector, Mr. Frank C. Pellett. This change becomes operative July 1. It is understood that Mr. Pellett will relinquish the work on his own motion, but no announcement has been made regarding his successor.

Mr. H. L. Seamans, assistant state entomologist of Montana, will be occupied with crop defense work throughout Montana this season. In addition to answering emergency calls to suppress outbreaks of insect pests, he will tour the state and conduct a survey of important pests. For the most part travelling in the various counties will be done by automobile in company with the county agricultural agents. Several outbreaks of army cutworms have occurred already and young grasshoppers are abundant in some localities in western Montana.

Mr. J. L. King, who has been at the Ohio Experiment Station for five years, assumed new duties in the Pennsylvania Bureau of Economic Zoölogy beginning May 1, and he will devote his entire time and attention to a thorough biological study of the Angumois grain moth, which, in the five southeastern counties of Pennsylvania most seriously infested, caused damage to the extent of more than a million dollars in 1916. The biology of this pest has not been thoroughly determined in this country, and the problem looks very interesting.

Mr. J. L. Webb, of the U. S. Department of Agriculture, Bureau of Entomology, has resumed work at Topaz, Calif., upon the Tabanids, *Tabanus punctifer* and *Tabanus phœnops*. This project is undertaken in coöperation with the Nevada Agricultural Experiment Station. Studies will be made in Nevada and in adjacent portions of California. These studies will include general data on the injuriousness of the flies, their effect on growth and milk production, the relation between the abundance of the flies and irrigation and drainage, together with biological data and studies upon methods of control.

Mr. Hubert Jarvis, assistant entomologist of Queensland, made a flying trip to Hawaii during February. In spite of the brief time that Mr. Jarvis spent in the Islands he was very successful in his mission, which was the securing of a considerable stock of the lantana Agromyzid flies for his government. The signal success of these flies in Hawaii, in preventing the seeding of this most troublesome weed, had led other countries to seek similar relief. This Agromyzid, which apparently is an unnamed species, was introduced into the Hawaiian Islands by Mr. Albert Koebele many years ago.

The following entomologists recently visited the Bureau of Entomology at Washington: Dr. G. C. Crampton, assistant professor of Entomology, Massachusetts Agricultural College, Amherst, Mass.; Prof. J. Chester Bradley, systematic entomologist, Cornell University, Ithaca, N. Y.; Mr. R. C. Shannon, Cornell University, Ithaca, N. Y.; Prof. James G. Sanders, economic zoölogist, Harrisburg, Pa.; Prof. W. L. Chandler, instructor in Entomology and Parasitologist of Cornell University, Ithaca, N. Y.; Mr. J. R. de la Torre Bueno, hemipterist, New York, N. Y.; Prof. A. B. Cordley, director of the Experiment Station, Corvallis, Ore.; Dr. T. J. Headlee, state entomologist, New Brunswick, N. J.; Mr. J. R. Malloch, University of Illinois; and Mr. W. C. O'Kane, state entomologist, Durham, N. H.

In 1906, when Bureau of Entomology Bulletin No. 61 was issued, there were laws in twelve states providing for the inspection of apiaries. Most of these laws have been since replaced by more effective ones. At present there are such laws in twenty-nine states, and in addition, Hawaii and Porto Rico have regulations to prevent the introduction of bee diseases. In all there are about one hundred apiary inspectors in the United States. Thirty-four states now have state associations of beekeepers and five have associations for marketing honey. In addition to these there are now many county associations.

The following recent appointments are announced in the Bureau of Entomology: James A. Dew, Federal Horticultural Board, to be stationed at Eagle Pass, Tex.; Merton C. Lane, to be stationed at Forest Grove, Ore.; Herman J. Hart, assigned to the field station Wellington, Kan.; Dean A. Ricker, field laboratory, West Lafayette, Ind.; F. M. Wadley, Wichita, Kan.; H. K. Laramore, Plymouth, Ind.; Arthur J. King,. Vashon, Wash.; O. A. Pratt, Calexico, Calif., transferred from the Bureau of Plant Industry. As collaborators in subtropical countries: Adolph Hempel, state entomologist of Sao Paulo, Brazil; Dr. Carlos E. Porter, director Institute Agricola de Chile, Santiago, Chile; F. W. Urich, government entomologist, Port of Spain, Trinidad; Archibald H. Ritchie, government entomologist, Jamaica; Patricio G. Cardin, government entomologist of Cuba, Santiago de las Vegas, Cuba.

The Connecticut mosquito drainage law has recently been amended by the General Assembly providing for a more comprehensive notice to property owners; for appeal and a method of assessing benefits and fixing damages; for state control of maintenance; that the law apply to work done before the passage of the present act if approved by the Director of the Agricultural Experiment Station; for the appointment of deputies; for one-fourth the cost of both maintenance and new work to be borne by the state, and the remaining three-fourths by the town, city or locality. The bill carries an appropriation of $10,000 to cover the state's portion, one-half for new work and the other half for maintenance.

The recent appropriations made by Congress for the Bureau of Entomology aggregate $931,480, being an increase of $62,600. For the control of the gipsy and browntail moths $305,050 is provided, and $25,000 is named for investigations relating to the cotton boll weevil, and lesser amounts are to be expended for special studies of

the Hessian fly, chestnut weevils, insects affecting pecans and other nuts, for the control of insect carriers of plant diseases in coöperation with the Bureau of Plant Industry, and for enlarging the work on insecticides. It is also contemplated that a field laboratory be established in the Ozark Mountain region in Arkansas and a field station in one of the New England States for investigations of the apple-tree tent caterpillar.

The Arizona legislature has appropriated $42,000 for the biennium beginning July, 1917, for the work of the state entomologist. Entomological work was organized in Arizona in 1909 with an appropriation of $3,000 supplemented by $600 from the Agricultural Experiment Station. Since then the successive legislatures have increased the appropriations from $3,000 a year to $5,000, $12,000, $14,000 and $21,000. The menace to the alfalfa crop by the introduction of the European alfalfa weevil into the adjoining state of Utah and the rapid development of the Egyptian cotton industry are factors largely responsible for the increasing interest shown in entomological work in the state of Arizona. After July 1, 1917, it is planned to add an assistant plant pathologist and a second assistant entomologist to the scientific staff.

Mr. Warren Knaus (class of 1882, Kansas State Agricultural College) has donated to the Entomological Museum of the Kansas State Agricultural College his valuable collection of Coleoptera. Ever since he was a student in the College, Mr. Knaus has spent practically all of his spare time and vacations in collecting and studying the Coleoptera. He has made many trips into the arid regions of Mexico, Arizona, Texas, and New Mexico to collect insects. These trips have been productive of a great many new species. His collection contains a number of species that are only found in one or two museums in the world, and these were furnished by Mr. Knaus. His collection will be kept as a separate one and will be known as the "Warren Knaus Collection."

An Insect Pest Survey and Information Service, has been undertaken by the State Entomologist of New York in coöperation with the New York State Food Supply Commission, the State College of Agriculture, the Farm Bureaus, the State Experiment Station and other agricultural agencies. It is also coöperating with the Emergency Entomological Service of the Federal Bureau of Entomology.

The main purpose is to secure prompt and accurate reports from all sections of the state, to summarize the information thus obtained, distribute it promptly and thus promote the checking or prevention in large measure of the enormous losses inflicted by insect pests. Particular emphasis is laid upon the initial signs of injury in order that damage may be anticipated and the insects controlled. The project is closely articulated with the control work in the field under the supervision of Messrs. Crosby and Matheson of Cornell University, and plans now maturing may result in what is practically an entomological patrol. The more important crops receive first attention, especially the insect enemies of potatoes, cereal and forage crops, truck and garden crops and the important fruits.

There are approximately one hundred observers reporting weekly and digests of the information with special recommendations in regard to the various pests are placed in the hands of the county representatives of the New York State Food Supply Commission and other interested parties with the expectation that every reasonable effort will be made to secure the general adoption of well-known and effective preventive or remedial measures.

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CONTENTS

JOURNAL
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Vol. 10 AUGUST, 1917 No. 4

LEAD ARSENATES, STONE FRUITS, AND THE WEATHER[1]

By Geo. P. Gray

The appearance of an unusual number of canker worms in the prune and apricot orchards of the Santa Clara Valley (Cal.) in the spring of 1915 caused a great many of the orchardists of that section to make one or two sprayings of lead arsenate in order to prevent defoliation of the trees. The worms were well controlled within a short time, but some two or three weeks after the application of the poison, it was noticed that the trees began shedding their foliage. The injured leaves were specked with brown spots, each speck being dead leaf tissue. (See pl. 16.) Some of the fruit was also injured in the same way. The defoliation in some of the orchards amounted to perhaps 50 per cent. while in others the injury was not as serious. Defoliation and fruit dropping was quite general, however, wherever lead arsenate had been applied for the canker worms.

It so happened that practically all of the lead arsenate used on prunes and apricots in the vicinity was purchased from a single firm. Some of the orchardists had never before been obliged to use an arsenical and so the use of arsenicals in general was condemned. Others thought that they had been supplied with a poor grade of arsenical, and threatened law-suits. The office of the County Horticultural Commissioner was besieged with inquiries as to the cause of the trouble. The situation was so unusual that the Commissioner (Mr. E. L. Morris) called upon the Insecticide and Fungicide Laboratory of the Agricultural Experiment Station for assistance in the

[1] Presented before the State Fruit Growers' Convention, Stanford University, July 26–31, 1915.

solution of the problem. The writer made two trips to the valley and spent several days in company with Mr. Morris visiting the injured orchards, interviewing the owners and securing data upon which to base conclusions. Five samples of lead arsenate were secured from different orchards which had suffered from spray injury. The matter was gone over quite carefully with Mr. Morris; representatives of two important manufacturers of lead arsenate were interviewed; and the samples were examined by the writer. As a result of the investigation, certain conclusions have been made and will be submitted later on in the paper.

In order that the discussion of the case may be better understood, it seems well to present some theories of spray injury, to describe the commercial types of lead arsenate, and to point out the recognized susceptibility of stone fruits to spray injury.

Theory of Spray Injury

For injury to result from the application of a spray, it is necessary that the material be absorbed in some way. It seems quite essential that the material should be in solution before absorption can take place. At least, there is no evidence that a solid can enter the tissue of plants or animals to cause lesions of any sort. The modern practice of applying arsenicals to foliage is based upon the proper combination of the poison in a form which is insoluble in water in order to prevent its entering plant tissue and causing damage. It is generally recognized that the damage which is sometimes caused by arsenicals is due to the part of the arsenical which is soluble in water and which may thus enter the tissue of the plant to disturb its functions.

Arsenic has been combined with many substances to find a combination which is the least soluble and the least affected by weather conditions, and to find a combination that is the most suitable for use in other ways. Of all the combinations thus far tried, a chemical combination of arsenic with lead seems to most fully meet the above conditions. At present, there are two types of lead arsenate upon the market, each having its own place in spray practice.

Types of Commercial Lead Arsenate

Acid Lead Arsenate; Lead Hydrogen Arsenate (often Labeled "Standard".)—In an investigation to find the most suitable form in which an arsenical could be applied to foliage, Mr. F. C. Moulton,[1] chemist for the Massachusetts Gypsy Moth Commission, selected lead arsenate as the combination most suitable for use in his work. This arsenical offered so many advantages over other arsenicals in use

[1] Mass. Bd. Agr. Rept., 41, p. 282 (1894).

Prune leaves injured by the decomposition of acid lead arsenate during a succession of light misty rains. Taken from the orchard of Mr. F. J. Shepherd, Edenvale California, May, 1915. (Natural size.)

previous to his work, that it is rapidly supplanting all other forms of arsenicals for use on foliage. This arsenical may be prepared by mixing in proper proportions a soluble salt of lead, usually lead nitrate or lead acetate, and a soluble salt of arsenic acid, usually sodium arsenate. The process has been perfected and cheapened by commercial manufacturers so that the use of these soluble salts, as raw materials, has been largely discontinued. At present, many of the manufacturers prepare commercial lead arsenate paste from lead oxide (litharge) and arsenic acid. This process greatly cheapens and simplifies the manufacture of the paste in ways which need not be discussed in this paper. As ordinarily made, there results a compound which may be spoken of in chemical language as an acid lead arsenate or possibly a mixture of this and neutral or basic lead arsenate. It was found that lead arsenate produced in this way gave very uniform and satisfactory results in most cases for the control of leaf-eating insects.

Basic Lead Arsenate (usually Labeled "Tri-Plumbic" or "Neutral").—The lead arsenate produced in the usual way, however, was found to produce very serious foliage injury under certain climatic conditions which prevail in the Pajaro Valley, the principal apple growing section of California. In the spring of 1903, field and laboratory work was commenced by the Entomological Division of the University of California to find a more suitable arsenical or to modify the known methods of preparation of lead arsenate so that it could be used without injury under the conditions prevailing in the valley.[1] The field work was conducted by Mr. W. H. Volck and Mr. E. E. Luther, students in the College of Agriculture. After numerous experiments, the process of preparation was so modified that a new type of lead arsenate was produced which could be used with safety upon the apple trees in that section. The modified process and some theories of foliage injury are discussed in the publication previously referred to. This new process lead arsenate was at first believed to be what may be termed a neutral lead arsenate. Our knowledge of the chemistry of lead arsenates is still very imperfect, but later investigations seem to indicate that the material produced in the manner described by Volck[2] may more properly be referred to as basic lead arsenate.

Comparison of the Two Types.—To take up a full discussion of the composition of the two types mentioned would be of too technical a nature for presentation in a paper of this kind. The acid type is very susceptible to the action of other chemicals and is more or less

[1] Volck, W. H., Science, N. S., vol. XXXIII, No. 857, pp. 866–870 (1911).
[2] *Op. cit.*

dissolved by chemicals of an alkaline nature which are commonly found in many spray materials. This property distinguishes the acid type of lead arsenate from the basic. The latter is not easily affected by alkaline chemicals and is a much more stable chemical compound under neutral or alkaline conditions. It is not easily made soluble by ordinary influences. A theory was advanced by Volck that the acid type of lead arsenate was decomposed by the small amounts of ammonia (alkaline) which are sometimes present in the atmosphere, producing a soluble form of arsenic. Under the conditions prevailing in the Pajaro Valley, there was present on the foliage enough moisture to dissolve the soluble arsenic, thus formed, and make possible its absorption by the foliage. The basic lead arsenate, on the other hand, is absolutely insoluble in ammonia and soluble arsenic cannot be formed in this manner. Whether this theory is correct or not has not been fully confirmed by other experimenters, but the fact remains, however, that the basic type is the safer arsenical to use upon foliage in the humid coast regions. The basic type is practically the only arsenical which may be safely mixed with any of the other spray materials as a combination spray. This has been fully tested out in the Insecticide and Fungicide Laboratory and has been found to be much more suitable when alkalies of any sort are mixed with it. The acid type is a stronger poison, however, and its action upon the insects is much more rapid. The basic type contains much less arsenic to the pound and a much longer time is required to poison insects.

The stronger and quicker acting acid lead arsenate is therefore the one to be naturally selected for use upon foliage which is not peculiarly susceptible to spray injury and where the weather conditions are not apt to cause its decomposition, that is, in the more arid regions away from the coast. The basic type should be used whenever an arsenical is to be mixed with any other material (with one or two exceptions) as a combination spray. The *basic type* is the one to be recommended for use in the humid coast regions and upon *all stone fruits* or any others which are especially susceptible to spray injury.

Susceptibility of Stone Fruits to Spray Injury

It is a well-known fact that the foliage of all stone fruits is peculiarly susceptible to injury from many kinds of sprays. This fact has been noted in respect to the use of arsenicals and the California Agricultural Experiment Station has advised that the basic type of lead arsenate should be the only arsenical applied to stone fruits. The wisdom of this advice has been doubted by a great many and the cause of the doubt is not difficult to find. If the weather is favorable, the acid type of lead arsenate usually may be applied with impunity. In

fact, this has been done in the Santa Clara Valley for a number of years with only occasional bad effects. This year, however (1915), has shown that this procedure is not a safe one and some other way must be chosen if the growers do not wish to take the consequences of defoliation and fruit drop due to the effect of unfavorable weather conditions upon acid lead arsenate.

The weather conditions that are believed to favor the decomposition of acid lead arsenate are a succession of light rains extending over a period of several days, continual foggy or damp "muggy" weather, and more or less warmth. A heavy rain is not as serious as a mist, for if there is a decomposition of the arsenate, a rain sufficient to drip from the leaves may wash off the soluble arsenic before its absorption.

Weather Record for the Period of Spray Injury

The following weather record covering the period of spray injury has been kindly furnished by Mr. W. H. Ward of Morgan Hill, Cal., who was one of the orchardists to suffer quite seriously from spray injury.

The rain records are taken in the morning about 7 a. m. and are as follows:

April 20	.66 inch
April 26	.27 inch
April 27	.14 inch
April 28	.11 inch
April 29	.11 inch
May 1	.11 inch
May 3	.38 inch
May 4	.97 inch
May 9	.20 inch
May 10	.22 inch
May 11	.16 inch
May 13	.18 inch
May 16	.31 inch
May 23	.07 inch

The spraying was done on the Ward ranch on April 19 and on the afternoon of April 20. The weather was damp when the spraying was done the first day and it rained the night following. The spraying was finished the next afternoon.

The amount of acid lead arsenate used was from 4 to 4¼ lbs. to 100 gallons of water. This was about the amount used by the other growers. The injury was noticed about two weeks after the application of the spray.

Theories Confirmed by the Investigation

As previously noted, five samples of lead arsenate paste were collected during the progress of the investigation. These samples were

taken from parts of kegs of the paste which were said to have been left over from the previous sprayings which had caused the injury. The labels were in some cases obscure, but from the information gathered from the labels, from statements by the growers and by the dealer supplying the arsenicals, it seems that the five samples represented at least three different brands of lead arsenate. Examination revealed the fact that they were all of the acid type. None of them contained an unusual or dangerous amount of soluble arsenic. In fact, one of the samples showed only a trace of soluble arsenic. The samples were in all respects normal as far as could be determined. Furthermore, the samples representing three different brands, it *seems improbable that all three of the companies should happen to produce a poor grade of material at the same time.*

The orchard of Mr. August Nielson in the Evergreen district near San José was visited, which consisted principally of apricots. There were, however, three rows of apple trees running across this orchard. The whole orchard was sprayed with acid lead arsenate on April 13. Five pounds of lead arsenate were used to the 100 gallons. Foliage injury and dropping of leaves and fruit was noticed before the first of May following. The whole orchard was uniformly sprayed with the strength of arsenical given above. It was noticed that spray injury occurred on the foliage of all of the apricot trees while no injury could be detected upon the foliage of the apple trees. The point brought out by the above observation is that the stone fruits only were injured, that the apple trees were uninjured, and that the lead arsenate used could not be considered of poor grade.

The adjacent orchard of Mr. R. Chaboya was also visited. This orchard consisted almost entirely of prune trees. Only a part of the trees in this orchard were sprayed, some of which were sprayed twice and some once. It was observed that the most defoliation resulted where two sprayings had been made. Wherever the trees had been sprayed, foliage injury was apparent. No foliage injury was observed upon the trees which had not been sprayed. This observation, as well as similar observations on other orchards, leaves no room for doubt that the injury had been caused by the spray.

Observations were also made on a prune orchard owned by Mr. F. J. Shepherd, Edenvale. Only a part of the trees had been sprayed. Those sprayed uniformly showed injury, while those not sprayed showed no injury. This observation confirmed the above. Many other orchards were visited. To record the observations made would largely be a repetition of the above. It was noticed, however, in this connection that occasionally a pear or an apple tree had been sprayed with the arsenical and in no instance could injury be detected, while

in every case where stone fruits had been sprayed, with acid lead arsenate, more or less injury was apparent.

Summary

According to the observations made of stone fruits to which acid lead arsenate had been applied during the month of April, 1915, they showed injury to a greater or less extent. Pome fruits which were sprayed under the same conditions causing the injury as above noted showed no injury. Examination of five samples of lead arsenate collected during the investigation represented three different brands. In no case did the analysis reveal the presence of unusual quantities of water-soluble arsenic. The samples were all good grades of acid lead arsenate. According to weather records and to the testimonies of the growers, a period of damp, misty weather prevailed during and after the application of the lead arsenate causing the spray injury. It seems reasonable to conclude:

1. The acid type of lead arsenate, often labeled "standard," is unsafe to use on the foliage of stone fruits except under favorable weather conditions.

2. According to weather reports, it appears that during the spring of this year (1915) (particularly during the month of April) unusually unfavorable weather conditions prevailed in the Santa Clara Valley, Cal.

3. The foliage injury in the orchards of the Santa Clara Valley this spring was due to the decomposition of acid lead arsenate by the weather.

4. According to previous experience and in accordance with previous recommendations of the University, the basic type of lead arsenate (usually labeled "tri-plumbic" or "neutral") is a safer arsenical to use on stone fruits and is not decomposed by unfavorable weather conditions. This is a slower acting poison, however, than the acid type and would not be as effective unless applied when the canker worms are very young.

Recommendations

In looking up the recommendations of entomologists and taking into consideration the experiences previously noted, it appears that there is a choice of three procedures for the control of canker worms:

1. Banding of trees has been found to give satisfactory results. Essig[1] may be cited as authority for recommending "tree tanglefoot" for the control of both spring and fall canker worms.

2. The acid type of lead arsenate may be successfully used on stone

[1] Essig, E. O., Injurious and Beneficial Insects of California, pp. 417 and 415.

fruits for the control of canker worms *provided the weather conditions are favorable.* It is *not recommended*, however, for general practice as there can be no guarantee of what the weather may be after the application of the arsenical.

3. It is *very strongly recommended*, when necessary to use an arsenical upon stone fruits, that the *basic type of lead arsenate be used exclusively.* In order that this slower acting poison may be effective, it will be necessary to keep a close watch of the orchards and make the application while the worms are very young.

WILD VEGETATION AS A SOURCE OF CURLY-TOP INFECTION OF SUGAR BEETS[1]

By P. A. Boncquet, *Bacteriologist, Collaborator*,[2] and C. F. Stahl, *Scientific Assistant, Truck Crop and Stored Product Insect Investigations, Bureau of Entomology*

The curly-top condition of sugar beets has for some time been a subject of investigation by phytopathologists, but on account of the failure to discover a specific organism responsible for the physiological injury to the plant, the problem has been peculiarly baffling. Although the connection of the jassid leafhopper, *Eutettix tenella* Baker, with the disturbance has been definitely established, conclusive evidence has not previously been available as to the exact nature of the trouble, or as to the part played by the leafhopper in the dissemination of the virus. It is believed that the results secured as herein related may be of assistance in establishing in part the nature of the disorder, the identity of its probable alternate hosts and the conditions governing its somewhat periodical or sporadic appearance in beet fields.

A brief review of the investigations leading to the experiments which will be mentioned may serve to emphasize the significance of the results obtained.

The connection of *Eutettix tenella*, known both as the sugar-beet leafhopper and the curly-top leafhopper, with the condition was first definitely established in 1909.[3] Soon afterwards it was found that a single leafhopper in any stage was capable of producing the condition

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[1] Published by permission of the Honorable Secretary of Agriculture.

[2] Since this article was first presented for publication, Doctor Boncquet has been absent in Argentina. He has not, therefore, had the opportunity of approving some of the corrections in the manuscript.

[3] Ball, E. D. The Leafhoppers of the Sugar Beet and Their Relation to the "Curly-leaf" Condition. U. S. Dept. Agr. Bur. Ent. Bul. 66, pt. 4, p. 33–52, pl. 1–4, 1909.

by feeding on a healthy beet for two minutes.[1] In these experiments it was further demonstrated that insects reared from the egg stage on healthy beets were unable to produce the characteristic condition

The curly-top leafhopper feeds on a number of species of wild plants, in addition to its attacks on the sugar beet. Specimens collected from wild host plants were accordingly tested on healthy beets, but without bringing about the curly-top condition.[2] They acquired the ability to cause the characteristic symptoms of the condition by feeding on affected beets. This ability was lost in from 15 to 35 days if the insects were transferred daily to healthy beets. A period of incubation, dependent on temperature, and lasting at least two days was required.[3]

The apparently sporadic occurrence of curly-top outbreaks in remote isolated desert regions, where beets had never before been grown suggested either that the leafhopper was capable of migrating to great distances, or that the virulent factor resided in other food plants than the beet, and was perpetuated either in a virulent form or in a symbiotic relation by these plants. The first being untenable, the second suggestion was investigated; the results obtained to the present time apparently justifying this paper.

Recent Investigations

Early in the fall of 1915 it was observed that many mallow plants (*Malva rotundifolia*) (Pl. 17, fig. 1) growing in the vicinity of beets affected with curly-top showed signs of abnormal development (Pl. 18, fig. 1). The plants were dwarfed and the leaves were irregularly contorted, the growing bud stunted, showing only two or three extremely small leaves, indicating a widespread disturbance in growth. Several of these abnormal plants were examined microscopically, revealing internal lesions similar to those observed in beets affected with curly-top. The phlœm was injured not only in the stem and roots but even in the extreme parts of the leaves. The medullary rays of the stem were also attacked and in some places showed total disintegration.

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[1] Smith, R. E., and Boncquet, P. A. New Light on Curly-top of the Sugar Beet. *In* Phytopathology, vol. 5, p. 103, 1915. Connection of a Bacterial Organism with Curly-leaf of the Sugar Beet. *In* Phytopathology, vol. 5, p. 335, 1915.

[2] Boncquet, P. A. *Bacillus morulans*, n. sp. Thesis presented for degree of Doctor of Philosophy at the University of California. University Documents, 1915. The Comparative Effect upon Sugar Beets of *Eutettix tenella* Baker from Wild. Plants and from Curly-leaf Beets (with W. J. Hartung). *In* Phytopathology, vol. 5, p. 348, 1915.

[3] Smith, R. E., and Boncquet, P. A. New Light on Curly-top of the Sugar Beet. *In* Phytopathology, vol. 5, p. 103, 1915. Connection of a Bacterial Organism with Curly-leaf of the Sugar Beet. *In* Phytopathology, vol. 5, p. 335, 1915.

Special staining methods demonstrated that organisms[1] similar to those previously found in affected beets were present. This striking resemblance suggested the possibility of the mallow being an alternate host in beet infection, and experiments were started to determine the relationship. In order to verify these assumptions two different methods were devised which, if successful, would furnish unquestionable proof. These methods were only the consequence of previous results obtained during investigations relating to virulent and non-virulent insects.

Experiments

In the first set of experiments two factors were most essential for success: (1) Insects must be used which were known to be non-virulent; and (2) beet plants must be used which had been grown under cover and were known to be healthy. Mallow plants (*Malva rotundifolia*) which showed signs of some disturbance (Pl. 18, fig. 1) were selected, growing in the field which contained a large number of beets affected with the characteristic curly-top. A microscopic examination disclosed internal disorders similar to those previously mentioned. Insects which had been kept under close observation for more than six months and which were known to be non-virulent were selected and placed on the mallow in small leaf cages. After several days these insects were removed and placed on healthy beet plants in specially constructed cages. These beet plants were kept under close observation and the first symptoms of curly-top noted (Pl. 18, fig. 2). One insect was placed on an affected beet instead of a mallow plant and was used as a check so that it could be ascertained whether or not the condition would develop normally during the fall season of the year. Table I shows the results of these experiments.

Table I.—Experiments in the Placing of Non-Virulent Specimens of Eutettix tenella on Affected Mallow Plants and Their Subsequent Transference to Healthy Beet Plants, Resulting in Curly-top Infection

Exp. No.	Date Placed on Mallow	Date Transferred to Healthy Beet	Date of First Symptoms of Curly-top	No. of Insects Used
1	Oct. 22, 1915	Oct. 27, 1915	Dec. 17, 1915	1
2	Oct. 27, 1915	Nov. 5, 1915	Jan. 10, 1916	1
3	Oct. 27, 1915	Nov. 5, 1915	Remained healthy	1
4	Oct. 27, 1915	Nov. 5, 1915	Nov. 29, 1915	1
5	Oct. 27, 1915	Nov. 5, 1915	Dec. 22, 1915	1

(Check on affected beet plant)

[1] Boncquet, P. A. *Bacillus morulans* n. sp. Thesis presented for degree of Doctor of Philosophy at the University of California. University Documents, 1915. The Comparative Effect upon Sugar Beets of *Eutettix tenella* Baker from Wild Plants and From Curly-leaf Beets (with W. J. Hartung). *In* Phytopathology, vol. 5, p. 348, 1915.

After remaining on the healthy beets for about two weeks all insects employed in the foregoing experiment were transferred to other healthy beets and the results were duplicated. Actual dates were not recorded, but all cases developed somewhat more rapidly than usual, due to the fact that the plants were kept in the greenhouse where the temperature was much higher. It will be noted from these results that the time required for the symptoms to develop was quite long, in fact much longer than was the case during the preceding summer in experiments with other phases of the condition. This unusual length of time was due to the unfavorable weather conditions prevailing later. The days were cold and cloudy and growth of the beets was practically at a standstill. It has been observed in these and other experiments that the symptoms of the condition do not appear unless the plant is growing. Two causes may be responsible for the fact that No. 3 did not show curly-top symptoms. Either the mallow was not affected, or the weather and the conditions in the beet plant were such that the organism was killed before it had a chance to develop. This assumption was more strikingly borne out in the following results, obtained from similar experiments at a later date. December 1, 1915, one of the same mallow plants was selected and six non-virulent insects placed upon it in a lantern globe. After a period of seven days they were removed and placed singly on healthy beets. None of these transfers brought about the disorder, all beets remaining healthy. As this mallow plant had been proven to be infected in the past experiment there is no doubt that unfavorable conditions were responsible for the negative results obtained. There may perhaps be a latent period in the life cycle of the causative agent while in the plant, or the agent may have been unable to withstand the unfavorable temperature.

The actual production of the condition in a healthy mallow plant by a virulent insect, and its subsequent transfer from the mallow to a healthy beet by a non-virulent insect, is the crucial point in the experiment. Small seedling plants for this test were grown in insect-proof cages and used as soon as they were large enough to be easily handled. First, six insects known to be virulent were placed on each mallow plant and were allowed to remain for a considerable period, after which they were removed. Non-virulent insects were then placed on the same plant and allowed to remain at least one week, when they were removed and placed on healthy beets. This experiment was conducted in a room in the laboratory where conditions were more favorable for the development of the condition. The results obtained are given in Table II.

Table II.—Experiment in the Infection of Healthy Mallow Plants by Virulent Specimens of *Eutettix tenella* and the Transference of the Curly-top Infection to Healthy Beets Through the Agency of Non-Virulent Specimens of the Insect

Exp. No.	Virulent Insects Placed on Mallow	Date Removed and Non-Virulent Insects Placed on Mallow	Date Placed on Healthy Beets	Date when first Symptoms of Curly-top Appeared	No. of Insects Used
1	Nov. 10, 1915	Nov. 30, 1915	Dec. 14, 1915	Jan. 20, 1916	6
2	Nov. 10, 1915	Nov. 30, 1915	Dec. 14, 1915	Feb. 15, 1916	6
3	Dec. 1, 1915	Dec. 15, 1915	Dec. 27, 1915	Mar. 10, 1916	6
4	Dec. 1, 1915	Dec. 15, 1915	Dec. 27, 1915	Mar. 29, 1916	6

Conclusion

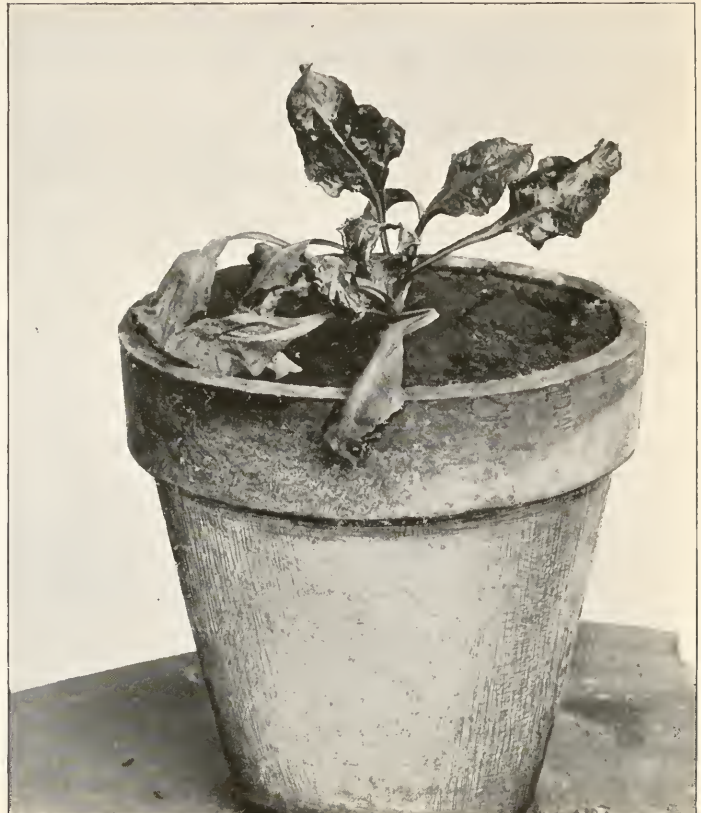
The foregoing experiments show the possibility that common weeds may assist in the perpetuation of the infectious factor which causes the curly-top of sugar beets. That these findings are of the greatest significance can be easily understood. Indeed they introduce a definite field of investigation for the control of this most destructive condition. One fact stands out most prominently from all evidence gathered up to the present time, namely, that the insects must be infected in order to be able to cause the disturbance. From their nature these insects in themselves are unable to produce the disorder. Hence, affected plants are required for reinfection of the insects before a general outbreak can be started. There must be present either some beets affected with curly-top in the fields or weeds which harbor the virulent factor, even in a symbiotic way. Clean cultivation, already extremely desirable from the standpoint of diseases and insect pests, especially during the period that no beets are in the field, is thus necessarily indicated as a means of prevention. Even though all vestiges of affected beets from the previous year have disappeared, and all volunteer beets have been eliminated, there remains the possibility that certain weeds, such as mallow, may harbor the virulent factor during hibernation. After clean cultivation has been put into practice attention must be directed to the surrounding native vegetation. The discovery of the original host plant among this vegetation is the next problem to be considered, and investigations are in progress to determine this point.

Summary

Malva rotundifolia, a common weed in the beet fields, has proved to be at least a symbiotic host of the virulent factor of curly-top of sugar beets.

Individual insects of the curly-top leafhopper (*Eutettix tenella* Baker) known to be non-virulent were placed on sickly-looking mallow

1



2

1, Healthy plant of mallow (*Malva rotundifolia*). (Original.) 2, Sugar beet showing typical curly-top infection. (Original.)

1

2

1, Mallow plant (*Malva rotundifolia*) harboring virulent factor causing curly-top of sugar beets. (Original.)

2, Beet plants showing effect of curly-top infection transferred from mallow plants. (Original.)

plants in the field. They were subsequently placed on healthy beets grown from seed in insect-proof cages. The condition was produced in four experiments.

Insects known to be virulent were placed on healthy seedlings of *Malva rotundifolia*. After a certain lapse of time they were removed and replaced with non-virulent insects which were later transferred to healthy beets. All transfers brought about the disorder.

These discoveries throw considerable light on the nature of the condition of sugar beets called curly-top, and establish beyond doubt the possibility of preventing or limiting injury by this condition through the control of the leafhoppers affecting the beets, and through the establishment of clean cultural methods, by means of which infected plants which act as hosts to the leafhoppers may be removed from the vicinity of beet fields.

RELATION OF THE COMMON ROOT MAGGOT (PEGOMYIA FUSCICEPS ZETT.) TO CERTAIN CROPS IN LOUISIANA

By E. S. Tucker, *State Agricultural Experiment Station, Baton Rouge, La.*

Attacks on Young Tomato Plants

A number of injured tomato plants ranging from five to six inches in length and a few specimens of a small maggot said to have been found burrowing in the stems of similar growth were brought to the writer for examination on March 3, 1914, by a merchant of Norwood, East Feliciana parish, La. He stated that a gardener of his home town had lost more than 1,000 plants like the samples, from stock grown under culture in a coldframe, all having failed in the short time of about two days. When the bed was covered on Saturday evening, February 28, the growth appeared to be perfectly healthy; but on opening the frames on Monday, March 2, the owner noticed many drooping plants, and by close examination, determined the cause of damage through discovery of some maggots in the stems. Other growers also complained that their beds were likewise being depleted.

The sudden loss of great numbers of plants in such manner naturally excited some alarm among the growers, who feared that the trouble might become more extended and thus restrict their production of a tomato crop for the approaching season. Since none of the gardeners had ever before known an enemy of this kind to do any harm to tomato plants, the question of its identity and life-history, and how to deal with it, presented an entirely new problem. For the benefit of the community, therefore, the merchant hastened on a visit to consult

an entomologist for the purpose of obtaining information about the pest and means of checking its ravages.

Careful examination of the injured plants submitted by him revealed two distinctive effects of attacks, denoting both external and mining tendencies of feeding by the enemy. As the stem was the only part showing violence, the plants had consequently received wounds in a very vital place. Even cuts of slight size appeared to have eventually produced nearly as fatal results as had been caused by extreme inflictions. Ample evidence of the primary and of course the more prevalent mode of attack was exhibited by the presence of scars. They also commonly demarcated the secondary damage that was disclosed by a tiny opening leading into the interior of the stem. These scars varied from a mere scraping to a rough cavity in the tissues, all being made conspicious by their black discoloration. They were located at different heights on the stem, ranging from near the roots to a distance of an inch or more above, but evidently depending on the depth of insertion in the soil.

In most instances, a plant had suffered but a single infliction. Burrowed stems, however, had usually become too weak to support the upper part of the plant, yet the fallen top remained attached at the infirm place by the shreds of withered tissues. The longest burrow found in any stem measured fully an inch. Every boring extended upward from a scar where a maggot had manifestly worked its way into the heart and there pursued its ravages. Although no additional maggots could be detected, the injuries were typical of operations by such creatures. The specimens at hand agreed very closely with a figure of the corn seed maggot. But positive identification of the species involved the necessity of securing adult examples or the actual fly.

While no occurrence of exactly the same nature had ever before come to the attention of the writer, yet reference to publications treating of maggots known to attack roots and stems of vegetables afforded a choice of several methods of protection against such foes, as recommended by authorities on the subject. Among the methods given, selection was made of two whose applications would seem to be most feasible under the circumstances, and a trial of each was accordingly proposed. One of the treatments required the use of oily sand, which should be prepared by mixing a cupful of kerosene in each pail of dry sand as would be needed, this to be placed close around the plants remaining in the beds. The other recourse depended on a liberal scattering of tobacco powder, which substance is claimed to serve as a fertilizer in addition to its repellent property against the maggots.

In order to render assistance based on practical experience in dealing

with this sort of enemy under Louisiana conditions, a visit for investigation was deemed expedient to acquire an understanding of the habits of the depredators with relation to the cultural practices of the truck growers, and to learn whether more than one kind of pest were involved or not, and also to determine the results of steps taken for preventing further harm by such foes. With this object in view, the writer proceeded to Norwood on March 6. For courtesies received, his thanks are especially extended to the merchant, who, in generous service to the growers, not only furnished accommodations, but gave his time, for facilitating observations.

Through a survey of the situation, not much difference was found to exist in cultural management, although some beds showed more careful preparation than others and had produced a superior growth of plants. As a general practice, the bedded soil had been heavily enriched with a commercial fertilizer said to have contained a quantity of cotton seed meal. Only one grower stated that he had used stable manure, yet his plants were beginning to fail. All the beds had been prepared solely for the forcing of tomato plants, being protected by the construction of a coldframe enclosing each one. While the entire stocks of these coldframes had been transplanted from seed beds, yet none of the growth left in the original places on account of its inferior size was said to be molested by maggots.

Since the owners of the depleted frames had made good progress in replanting them, leaving the surviving plants of the first lot as they already stood, but filling in with a fresh supply taken from seed beds, the great loss of stock so far sustained was therefore only partially shown. Enough evidence was seen and learned, nevertheless, to prove that the extent of damage together with imminent danger of further ravages had brought the growers to face a grave predicament. The replacements of plants necessarily consisted of smaller growth than was desired, and unless these settings could be saved, the reserve stocks in seed beds might be insufficient to depend on for growing as much of a crop as was planned, besides being apt to mature late. A shortage of the advanced growth would handicap the producer, at least by limiting the yield of fruit in time for market early in the season when high prices rule.

In all the instances where depredations had been committed, nothing else than maggots could be held accountable for the principal destructive work. Very seldom was any indication of cutworm damage or sign of disease apparent.

One gardener, whose stock was inspected, claimed that he had lost about 3,000 plants of a size like the living growth of the same lot left in his coldframe. These remaining plants averaged 8 inches in

height measuring from the base of the stem. The spaces made vacant by the losses had just been reset with slightly smaller stock. Yet scarcely any of the plants kept from the first setting were found to be in a sound state. Most of them looked healthy as they stood, showing no injury above ground, when in fact, nearly every stem proved to be blemished by one or more wounds, all of which had been originally inflicted only on the part buried in the soil.

Deterioration by withering and decay following upon the wounds had in many cases reduced the tissues to shrunken and blackened shreds which broke apart on the slight strain of a pull exerted by efforts to lift the plants. Such defects commonly marked the starting point of a boring that penetrated upward through the soft heart, and these bored stems occasionally contained a maggot. During the day before, the owner took a number of withered plants and showed them to the merchant, who on opening the cavities, exposed as many as seven maggots infesting a single stem.

The heart of some stems had been excavated up to the juncture of the lower branches, and in one instance, a burrow extended onward for a short distance into a thick branch itself. Among the plants examined here, one happened to attract particular notice on account of a bunch of new rootlets which had grown out from the base of the stem just above a breach, the lower portion with the original root system having become withered and practically dissevered. Although the vitality of this plant indicated that it might attain to a fair growth, provided no other harm should befall it, such an event, however, could only be considered as a bare possibility.

A visit to the coldframes of another grower afforded a view of the effects of ruin as were displayed by part of a bed not yet replanted. Judging by the havoc presented here, the owner's opinion that his loss of stock amounted to 75 per cent of the entire first planting seemed to be well founded. By taking his estimate of shortage and allowing it to include all additional failures bound to occur among the remainder of the plants, a very conservative comprehension could be derived in respect to the plight of growers at large.

Menace to Garden Peas and Seed Potatoes

Attention was also called to depredations committed on young garden pea vines in the same locality, but the plants appeared to be fully able to withstand the injuries although the stems were badly scarred at points beneath the soil. So far as was ascertained, the stems had only suffered abrasions not much more than skin deep. The firm structure of the heart had evidently proved to be impregnable against attacks, and had therefore saved the plants from fatal damage. Search

for the enemy revealed it only in the pupal stage occurring in the soil at short distances from the plants. The finding of the pest in this form established the fact that the destructive stage, or maggot, had ceased its ravages in this field.

The work of maggots in seed potatoes could only be briefly investigated, but it certainly foreboded disaster to the planting that was first inspected. Tubers that were dug up for examination consisted in part or almost wholly of a rotten mass infested with the maggots. Reduction of the parent stock in such manner meant that the sprouts must soon die for lack of nutriment. In a field of more recent planting where the tubers had just started to sprout, no defects came to view, although the stock was found to be endangered by numbers of maggots which reveled in the decomposing cotton seeds that had been put in the rows for fertilization of the crop growth.

Infestation of Cotton Seeds used for Fertilizer

The discovery of the maggots existing among the rotting cotton seeds buried under several inches of soil incited comment in regard to the manner in which the infestation could have been initiated. The introduction of these forms could not be explained in a way to satisfactorily attribute sufficient ability on the part of the pest at any stage to gain access into such a situation. The problem, however, admitted of a simple solution which happened to be revealed through remarks ventured by the grower. He pointed out the probability that the cotton seeds had become infested with maggots previous to the time when they were scattered in the field. According to his statement, he used these seeds for fertilizer because in the first place they constituted a quantity which by exposure to rain had been rendered unfit for planting or for sale. While being cast aside in such condition, the pile of spoiled seeds had likely attracted parent flies which had then deposited their eggs in the damp decomposing mass, thus resulting in the development of maggots under very favorable circumstances.

Comments

As adult flies cannot oviposit below the surface of the ground to any depth, no maggot on hatching from an egg placed on the soil would be able to penetrate far down unless guided by the stem of a plant. By such means as the latter, the maggots can without doubt reach the tubers of potato sprouts.

In proposing an experiment for the benefit of a grower, he was asked to place a few glass jars in an inverted position over some of his failing plants for the purpose of trapping a number of flies when they should emerge from the enclosed soil after completing their develop-

ment from the maggot stage. Specimens captured in this way were desired by the writer for study, but the arrangements failed to be carried out.

However, adult flies collected in and near the coldframes on March 6, and reared ones maturing on March 26–31, from infested material consisting of earth and pea sprouts, potato tubers and cotton seeds, filled expectation of the species being *Pegomyia fusciceps* Zett.

Destruction of Other Potato Plantings

As a matter of previous record concerning the same insect, a complaint of damage to seed potatoes, accompanied by a sample of the tubers showing infested condition, was received from Valverda, Pointe Coupee parish, La., bearing the date of March 19, 1913. The sender stated that the tubers had been planted during the month before, the planting having been begun on the 18th. The fields thus planted comprised about 20 acres in the Triumph variety and 5 acres in the Irish Cobbler. All of the seed stock had been obtained from Maine and it had arrived in excellent shape. However, it was treated with formalin; and as far as could be seen, germinated nicely. A good many little sprouts duly appeared above ground but were nipped by a frost on March 16.

Upon examining the propagating tubers on the day as noted by letter, every piece of potato without exception that the planter then dug up was found by him to be infested and practically spoiled by small maggots. He further asserted that the same enemy had occurred during past years in considerable numbers on seed potatoes, but not to the extent of spoiling them. As a large part of his present plantings had been made on land that had never produced potatoes, he was at a loss to account for the general prevalence of the foe. It operated just as numerously on the plantings in such land as on others in ground where a potato crop had been grown before. The fields were said to have been well drained, the soil having remained loose and in good tilth even after the heavy rains of the preceding week.

While acknowledging that the damage done at the time left little hope for a crop worth cultivating, yet the grower asked for information about remedies and also desired to know if any similar case where the prospective growth had been ruined had ever come to the attention of the writer or his agricultural associates. No satisfactory advice could then be given in reply since the injuries under such circumstances presented a subject concerning which no dealings had been experienced in Louisiana and but scant enlightenment was available. As was shown by the sample, decay had followed the attacks by the maggots until the combined ravages by both agents had greatly reduced the supply of nutriment in the parent stock.

Not knowing, however, but that the sprouts might yet succeed in establishing themselves, the presence of the maggots was consequently on first notice not regarded by the writer as a serious menace. But a subsequent report made by the planter, under date of April 17, conclusively affirmed the opposite of this impression. He then wrote that the results were just about what he had expected: no stand was secured at all from the impaired seed stock, though a later planting attained to perfect growth.

Adult flies, which proved to be the species, *Pegomyia fusciceps* Zett., matured on April 1–3, from the maggots received in the rotting tubers for examination.

Another loss of a planting of seed potatoes on account of attacks by maggots occurring again in Pointe Coupee parish, which complaint was made by a grower at Ventress, under date of April 1, 1915, seemed to indicate that some especially favorable condition for the pest existed in the country there. The stock was said to have been obtained from Maine, then having been planted on March 6. At the date of writing, all of it had become rotten, which state was attributed to the work of "worms." The samples submitted for examination consisted of rotten pieces of the potatoes infested by numbers of maggots. To all appearances, these larvæ represented the species *Pegomyia fusciceps* Zett., though they failed to produce adults.

The possibility that the maggots might not have been entirely to blame for the rotting of the tubers was pointed out in reply to the grower's request for information. Their occurrence may have followed decomposition induced by cold wet soil. In case the growth of sprouts had been delayed by the latter conditions, the seed had very likely started to rot before the parent flies deposited their eggs, with the result that the issuing maggots were immediately attracted to the rotting tissues. Owing to their scavenger habits, the maggots naturally reveled in the decomposed matter and therefore hastened the spoiling of the seed.

If means in accordance with a better knowledge of the pest at this time had been employed early enough to prevent the maggots from reaching the seed, the prospect of obtaining a stand of sprouts might have been insured. The most practical measures in such respects would have depended on spraying the sprouts as soon as they had appeared above ground, with a solution of lead arsenate, preferably in combination with Bordeaux mixture. But the best that could be done in case the stand of plants proved to be inadequate for a crop would be to replant the field.

Killing Young Corn

A correspondent writing from Tallulah, Madison parish, La., on April

30, 1913, sent a few young corn plants which he stated had been gathered from a field where the crop growth was being destroyed by "worms" attacking the base of the stalks. He asserted that this corn had come up to a perfect stand, but at the time of writing, a great many of the sprouts had died, while others looked unhealthy as if affected by disease. Still some appeared outwardly to be sound and vigorous although being generally found infested by the worm-like enemy. A large part of the field had already been plowed up and planted to cotton, but he had left a portion for an experiment to determine whether the plants would be able to recover and produce a crop or fail to be worth further attention.

In response to his request for an opinion regarding the outcome of the latter course, and for suggestion as to any method by which the foe might be exterminated, very little advice could be given, because preventive measures are about all that can be employed against enemies of such nature. Then the application of precautionary treatments for field crops such as corn would likely be of questionable value considering the cost of labor and material required.

His belief that the pest was a larval form of some species of beetle failed to be sustained by examination of the material furnished. Injuries to the stalks were observed to have resulted from small shallow cavities evidently caused by a scraping away of tissues on the base close to the roots. Only a few dipterous larvæ could be detected, and all occurred in the cavities of one plant. The insect was regarded as the common root maggot (*Pegomyia fusciceps* Zett.), also called the seed-corn maggot. It therefore appeared to be the real culprit responsible for the attacks.

The absence of larvæ in the other stalks given examination may have been due to the emergence of the forms from the cavities and consequent loss in transit, or else the maggots had gone into the soil for pupation before the plants were collected. The damage inflicted was entirely different from that of deeper bored injuries as are committed by the southern corn rootworm (*Diabrotica duodecempunctata* Oliv.), which insect commonly ruined early stands of corn in the central and lower sections of the state. Neither were the roots attacked nor stems bored in this case. The plants measured from 12 to 15 inches in height and had pushed out short prop roots. As not enough maggots could be secured for rearing of the species, the name as cited should be substantiated by positive determination of the insect involved.

Pest of Hotbed with Tomato and Cauliflower Seedlings

On receipt of specimens of insects taken from a hotbed, which material accompanied an inquiry forwarded from Edgard, St. John the

Baptist parish, La., January 21, 1916, an examination of them revealed a single adult fly of the species *Pegomyia fusciceps* Zett., a plump red mite which may have been an enemy of the fly, and a number of springtails, possibly *Smynthurus sp.* The transmitter thought that such insects had cut the roots of the young plants and also eaten some of the tomato and cauliflower seeds. Advice was requested as to what treatment should be given. Answer to this question is covered in extract presented under the heading of "Reference." Considering that the occurrence of the fly indicated an infestation of the bed by maggots of its kind, the cutting of the roots of the plants could well be attributed to attacks by the latter form of pest. These injuries might have been made worse by work of the springtails, which very likely did other harm, including the destruction of the seeds.

Ravages in Onions

Ravages committed by the same insect in onions were brought to attention through a report which came to hand from Paulina, St. James parish, La., dated January 22, 1916, stating that a pest in the form of a "worm" had cut into the plants at the surface of the ground. The trouble occurred in a patch of transplanted Creole onions which had been put out three weeks before on land that had produced sorghum during the preceding summer and Irish potatoes for a fall crop. Other patches of onions planted where sweet potatoes had been grown were declared to have no enemy of the kind at all. In the first plat, the foe was found by opening the little onions. It was described as a white worm of small size, measuring about one eighth of an inch in length and being no thicker than a needle.

As desired, samples of the infested onions were transmitted six days later. From specimens of the insect thus obtained, the species was identified by Mr. W. R. Walton, Federal Bureau of Entomology, through the kindness of Dr. F. H. Chittenden. The instructions furnished in regard to treatments for checking further advances of the pest emphasized the importance of pulling up and destroying all the infested onions in order to kill the maggots before they could develop into flies. Warning was given that the insect if allowed to mature would be able to reach other patches, and these adults by depositing their eggs all through the fields would be very apt to bring on a widespread infestation with the issue of a new brood of maggots.

Reference

Tucker, E. S. Stem Maggots Attacking Young Tomato Plants. 1914. Southern Farmer (Baton Rouge, La.), vol. 1, No. 9, May, p. 9.

A notice of the losses experienced by the growers at Norwood, La., contains the following remarks on control of the insect: "Practical methods of checking or preventing attacks on the tomato plants were promptly employed, and two kinds of

treatment gave promise of good results. One depended on a liberal scattering of tobacco powder on the beds. This material is claimed to serve as a fertilizer in addition to its repellent action on the maggots. The use of a trade preparation called 'Pyrox,' which was sprayed on several beds of plants, seemed to afford almost complete protection to the growth. Where such applications had been made upon plants at time of setting and later, the stock was not molested by maggots nor even cutworms, and showed no sign of disease. Growers who adopted this course secured stands of advanced stock. That the enemy was overcome by the above means is evidenced by the absence of any further complaint, and a full tomato crop is therefore believed to be assured."

A BUPRESTID HOUSEHOLD INSECT (CHRYSOPHANA PLACIDA LEC.)

By H. E. Burke, *Specialist in Forest Entomology, Branch of Forest Insects, Bureau of Entomology, U. S. Department of Agriculture*

During the past year, this species, through a slight change in habit, has become, locally at least, an injurious household insect. Normally it lives in the wood of dead limbs, tops and scars on the trunks of living trees. Fire scars and blazes are very often found to be infested in the higher mountain regions of the Rocky Mountain and Pacific states. The larvæ mine the wood riddling it with the small worm holes which are filled with the fine dustlike borings. In the average forest a good deal of damage is done to the timber of the trunks of injured standing trees.

It is not such a long step from the wood of the standing tree to the wood of window casings and door frames. This seems to be the first case reported, however, where a Buprestid normally living under the same conditions as *Chrysophana* has made the step.

In the case under observation the frames of several windows in various office buildings in Placerville, Calif., were found to be riddled by the mines of this species and adults were taken in the act of emerging from the wood. One building was erected over thirty years ago and another over twenty so the casings evidently were infested long after the buildings were erected. The work indicated that the wood had been infested and reinfested several times and probably in a number of cases the adults never left the room into which they had emerged but mated and the females oviposited in the same casings or adjoining ones. The casings appeared to be of sugar pine (*Pinus lambertiana* Dougl.).

That this species is quite adaptable in regard to host is also indicated by the fact that it is a burrower in cones. During the past few years it has been found several times in the cones of the knobcone pine (*Pinus attenuata* Lemmon). These cones remain on the tree a number of years and are hard and dry, more like a branch than the average cone.

The life-history of *Chrysophana* is very much like the life-history of

the average wood-boring Buprestid. It lives in the wood as a larva for two or three years and pupates and transforms to the adult in a pupal cell in the wood. Pupation takes place from July to October and the transformation to the adult in a few weeks afterward. The adult then rests over the winter in the pupal cell and emerges from the wood the next spring or summer, from March to September. Adults have been collected flying or crawling in the forests from March 20 to August 24.

During the past fifteen years *Chrysophana placida* has been taken by members of the Branch of Forest Insects, Bureau of Entomology, United States Department of Agriculture, in the localities and host trees listed herewith.

Distribution

California: Fallen Leaf, Pyramid Ranger Station, Placerville, Markleeville, Shingle Springs, Sterling, Yreka, Tallac, Lake Valley Ranger Station, Echo Lake, Meyers, Wrights Lake, Monumental, Vade. *Colorado:* Florissant. *Oregon:* Sumpter, Waldo, Ashland. *Utah:* Panguitch Lake, Kamas. *Washington:* Des Moines.

Host Trees

Mountain, white or silver pine (*Pinus monticola* Dougl.), sugar pine (*Pinus lambertiana* Dougl.), single leaf pinon (*Pinus monophylla* T. & T.), yellow pine (*Pinus ponderosa* Laws), rock pine (*Pinus scopulorum* Engelm.), jeffrey pine (*Pinus jeffreyi* Oreg. Com.), lodgepole pine (*Pinus murrayana* Oreg. Com.), digger or gray pine (*Pinus sabiniana* Dougl.), knobcone pine (*Pinus attenuata* Lemmon), black hemlock (*Tsuga mertensiana* Carr.), Douglas spruce (*Pseudotsuga taxifolia* Britton), Alpine fir (*Abies lasiocarpa* Nutt.), white fir (*Abies concolor* Parry), red fir (*Abies magnifica* Murr.), giant arborvitae or western red cedar (*Thuja plicata* Don.).

CONTRIBUTION TO THE LIFE-HISTORY AND HABITS OF THE SPINOSE EAR TICK, ORNITHODOROS MEGNINI

By William B. Herms, *University of California*

The spinose ear tick presents a problem of considerable importance to the animal husbandryman in nearly all of the southern half of California, particularly in the Imperial Valley where calves become seriously infested and die from what the ranchers call tick fever. Experiments and field observations on this species have been carried on more or less continuously by the University of California Laboratory of Parasitology during the past three or four years. From our records it would seem that few if any warm-blooded animals coming within the reach of this tick are exempt from attack. Calves evidently are most liable and suffer most severely, many dying from the effects.

Infested calves shake the head vigorously, become emaciated, often race about madly until completely exhausted. The ears become inflamed and the secretion of wax is greatly stimulated. Deafness is said often to result in infested horses and mules.

The following account is by a man whose ear was inhabited by a tick of this species. This account is worthy of note because the course of events is here rather accurately given, together with the sensations aroused and other matters of interest. Mr. L., writing from Lancaster (California), states: "I left Berkeley with a horse and wagon on the 3d of September (1915) and drove about four hundred miles to Lancaster, Los Angeles County. I slept on the ground every night except one, arriving here on September 15. Some of my camping places were in, others along-side of, cattle ranges or pastures. One of the places I discovered before morning to be a regular camp for twenty or thirty cattle of all sizes. This is where I did not sleep on the ground. The cattle came in after I had made camp about dark and it was too late for me to find another place, so I moved my bed into a small shack, near the barn with old straw on the floor, which was about a foot above the ground. Still I was right among the cattle. This was the night of September 5, at Corrall Hollow, east of Livermore. The last night out, September 15, I slept on land that is used only for grazing and have been working on similar ground ever since; however, there are only a few cattle on the range. My other sleeping places were mostly along the roadside, and sometimes cattle were around. At other places there were none and I think there have been no cattle near the house I live in for several years, or perhaps a few passing near it once in a while." Our records show that Mr. L. went through territory where the spinose ear tick occurs. In his first letter, dated December 10, 1915, he says "I am sending you . . . a bug . . . which came out of my ear, and which was living there probably six or seven weeks. . . . About six or eight weeks ago I began hearing unusual noises in my left ear. Sometimes hours would pass without hearing them; sometimes every few minutes, either day or night. The noise would saw awhile without any regularity as to time or duration. I could feel no movement in my ear like anything alive. Finally I thought I had better have it examined, so went to a local physician and told him I thought something was in my ear. He examined it and said 'Yes, there is something in there. I'll see what it is and what I can do for it.' After prodding around awhile he asked, 'What do you suppose that thing is in there?' I replied that I did not know. 'Well, it is a live bug, but I killed it.' He pulled out what looked like a clot of good red blood, about the size of a small pea, mixed with small bits of soft membrane. Then he

washed the ear with peroxide and gave me the syringe and a bottle of peroxide and told me to wash it a couple of times a day for two or three days. . . . I used the peroxide as directed, but the noises did not seem to stop and soon I concluded that they were about as before. . . . Finally I made up a dose of peroxide as hot as my ear would stand and about the third or fourth shot with the syringe this ugly thing came tumbling onto the ground, and the ear has been apparently alright ever since. This was last Tuesday, December 9, nine or ten days after the doctor did his job."

The above letter furnishes evidence to the effect that the tick entered the ear of the man while sleeping on the ground sometime between the third and fifteenth of September. From what is already known of the habits of the species, the tick almost certainly entered his ear as a larva. The specimen which left the ear of the patient December 9 was a full grown female. The time was, therefore, about nine weeks. This specimen remained alive without food in a small shell vial on the writer's desk until about December 1, 1916, nearly a year, during which time there were no further molts.

Oviposition

In order to ascertain the exact time expiring between the last molt and the deposition of eggs, a number of females previous to the final molt, were placed in Petri dishes with one or more males and kept in an insectary at 26°±3° C. except female No. 3 (see table) which, after about 60 days, was subjected to temperature as low as 0° C. The following table shows the result of this experiment.

Table I.—Showing Time Required between Final Molt and Oviposition, also Date of Copulation, Number of Ova

No.	Date Molted	Date Placed with Male	Date of Copulation	Date of Oviposition	No. of Ova Deposited	Days between Copulation and Oviposition
1	10/22/15	10/23/15	10/23/15	11/ 6/15 11/ 8	10 44 } 54	14
2	10/24/15	10/27/15	Not observed	11/24/15	186	28(?)
3	10/24/15	10/27/15	10/27/15	11/27/15 12/2 12/ 3 12/ 4 12/ 6 12/ 8 12/20 3/24/16 4/13 4/30	7 12 19 5 88 94 43 166 103 25 } 562	31
4	10/19/15	10/21/15	Not observed	12/ 5/15	7	37(?)
5	10/23/15	10/23/15	10/25/15	12/ 6/15 4/16/16 4/27	117 Not counted Not counted	42
6	10/24/15	10/30/15	11/ 5/15	3/15/16 4/1	25 Not counted	100
7	10/20/15	10/30/15	Not observed		No ova	—

An examination of Table I shows that copulation took place readily within a day or two after the last molt, and that in six cases egg deposition began in from 14 to 42 days after copulation or from 15 to 44 days after the last molt, with the number of ova ranging from 7 to 562. The longest period of oviposition noted was 155 days or 189 days after molting.

Incubation Period

Unfortunately a careful record of all egg layings was not kept, but the records made in this connection are of interest nevertheless (see Table II).

Table II.—Showing Incubation Period for Ova of Ornithodoros megnini

Date of Oviposition	Date Hatched	Incubation Period	Temperature
11/ 8/15	12/1/15	23 days	Room temperature 21° C.± (steam heat regulated by thermostat)
11/24/15	12/11/15 to 12/14/15	18 to 21 days	Ditto
12/ 2/15	12/22/15 to 12/24/15	20 to 22 days	Ditto

The above table though based on few observations shows that it is possible to secure oviposition during the winter months (November and December) and that the eggs hatch in a room temperature of about 21° C., requiring from 18 to 23 days incubation.

Longevity of Larvæ

In a series of experiments in which the larvæ were kept in darkened receptacles at room temperature, during the months of November, December and January it was found that the range of longevity was from 19 days, the shortest, to 63 days, the longest, with an average of 44 days. This series included seven sets of larvæ hatching during a period of 32 days.[1]

Conclusions

The spinose ear tick, *Ornithodoros megnini*, enters the ears of both man and beast causing losses particularly in calves.

Oviposition and emergence of larvæ may take place during the winter months, November, December and January, under laboratory conditions. It should be borne in mind that under field conditions this takes place during the summer and autumn months.

The adult female may live 355 days without food in a glass vial at room temperature.

[1] The writer wishes to acknowledge the assistance of Mr. M. H. Ray, a student in parasitology, who deserves much credit for his patience and care.

Copulation takes place within a day or two after the final molt.

Oviposition occurs in from 14 to 42 days after copulation with a maximum period of oviposition of 155 days.

The number of ova per female ranged from 7 to 562.

The incubation period at room temperature ranged from 18 to 23 days.

The longevity of larvæ ranged from 19 to 63 days with an average of 44 days.

A FLY CONTROL EXHIBIT

By C. W. Howard

In the autumn of 1915 it fell by lot to the writer to prepare for the State Fair, the major portion of the exhibit of the Division of Economic Zoölogy, of the Agricultural Experiment Station. The task seemed difficult, for in years past we had nearly exhausted the possibilities of preparing a new and interesting display of destructive insects. But as we have been trying for some time to impress upon our rural and farming population, certain facts about house-fly control, this seemed to be the opportunity to press home some of these facts in a telling way.

In preparing the exhibit, we had in mind the fact that fly elimination on the farm is extremely difficult, and that especial attention must also be given to sanitary arrangements, as well as to actual fly control in order to prevent disease transmission. Sanitation has been sadly neglected on most Minnesota farms, but the more progressive farmers are awakening to its necessity and are ready for suggestions.

The exhibit was called, "The Flyless Farm." A farmstead about 10 x 15 feet was laid out. The Division of Farm Management was called upon to advise as to the proper relation of the buildings, and the Division of Engineering for plans for the buildings. The entire exhibit was, therefore, correct in every detail and in accordance with the recommendations which the Experiment Station is sending out to farmers.

For the actual construction of the buildings, etc., we were fortunate in securing the services of one of our students, who is unusually apt at mechanical work. "Compo-board" served admirably as constructive material. The buildings were so made as to be collapsible and easily packed for transportation. They were of large size, built to a scale of one-half inch, the house for example being 14 x 15 inches, and the horse barn 18 x 25 inches, so that every detail could be practically perfect. This accuracy of details fixed the attention of many observers. A large green painted canvas covered the table on which the exhibit was placed, with the roadways marked out in gray.

The following buildings were shown: dwelling, dairy barn, horse barn, hog house, milk house, and outdoor toilet. The only necessary farm building lacking was the poultry house. Every building was fitted with screens over windows and doors, and the hog house had swinging doors into the run-ways, with miniature pigs passing through. At the door of the dairy barn was shown a miniature manure spreader receiving a load of manure from the manure carrier and ready for the daily removal to the field. On the other side was a model of a maggot-trap. At the horse barn were shown manure bin and manure closet for we knew that many of our visitors would be from villages and towns where such outfits could be used.

The milk house was removed from the stables, and beside the water tank. Windows and doors were fitted with screens, and a screened enclosure contained shelves on which pails and tins were airing. The dwelling, besides screens on windows and doors, was provided with screened porches, both front and rear. At the back door was a garbage tin. A portion of one side of the house was removed to show connection of kitchen sink and washbowl, bathtub and closet in the bath room, with a sewage system. At a convenient distance from the house, a model Imhoff septic tank was let into an excavation, connections to the house and outlet being indicated. The outdoor toilet was a perfect model of a flyproof, sanitary privy, of the bucket type.

An abundance of labels explaining every detail and a leaflet, which had been prepared on fly control to accompany this exhibit, gave full information to those who did not wish to ask questions of the attendants.

The success of this exhibit was much greater than had been anticipated and many people went away with a definite idea about farm sanitation, especially about the construction and use of septic tanks.

The cost of the models was not very great, approximately six weeks were required for construction. Labor and material have totaled about $200, the cost of publishing the fly leaflet being in excess of this. This year the flyless farm has been again exhibited at the State Fair, at the request of the Women's Federated Clubs, and will also visit several county fairs.

We are making additions to it as they suggest themselves. For example, this year we have added a model of a mosquito-proof water tank at the corner of the house. The models are very durable and we hope will last long enough to visit every county fair in the state on their mission of better farm sanitation. To the average individual in Minnesota, whether rural or city dweller, it conveys more practical information on the house-fly question, than all the leaflets we have ever printed.

Minnesota Fly Control Exhibit

A FEW NOTES FROM KENTUCKY

By H. Garman, *Lexington, Ky.*

With a very cold, cloudy, backward spring, insect problems have not come to the front in Kentucky as early as usual, but several insect pests have already claimed some attention.

The Hessian fly is being closely studied in the western end of Kentucky with a view to learning more of variations in its life-history from season to season. The adults have been abroad since March 25 on wheat sown September 28 and are numerous in that end of the state, though the wheat itself was in many places destroyed by frost and the promise for a crop is very unsatisfactory. The evidence secured by us last fall and this spring shows that owing to the influence of excessive drought in delaying volunteer wheat and also in keeping farmers from planting early, few or no adults emerged in the fall of 1916. But when flaxseeds were brought indoors at that time the adults came out in a few days, showing that they were ready and would probably have emerged in 1916 as they appeared to have done in 1915, if we had had a week more of warm weather. As it chanced, cold weather put a stop to their activities in October. With the first warm days they came out this spring. I am still of the opinion that a brood of adults matures in the fall in this region during some of our long open falls. We hope to solve this question next fall.

The buffalo gnat (*Simulium pecuarum*) was abundant for a day or two in one county in Western Kentucky this spring. Some mules were actually killed by it. It disappeared as suddenly as it came, leaving farmers wondering as to where it came from, some of them holding that it came from some distance on a cold west wind. Examination of the locality showed it entirely unsuited to the breeding of the insect. The streams are small, and dry up completely, it is said, in summer. Some pupæ of a Simulium were collected at the time in partly submerged willow in the edge of a creek. These appear to be of the type of *S. venustum*, though a determination based upon the pupal characters seems not to be safe in view of present knowledge of the life-history of our species. As a matter of fact, in the two cases of outbreaks of buffalo gnats which I have investigated in Kentucky, neither larvæ nor pupæ that can be considered as belonging to the species were discovered, and the local conditions were not such as have been described as suitable for the breeding of the pest. It is evident that there is much yet to learn about the life-history and habits of the buffalo gnat.

The Red-legged Flea-beetle (*Crepidodera rufipes*) of Peach Trees.—The first instance of injury from this introduced pest in Kentucky came to my attention in the shape of specimens sent me from Lewis County, May 4, 1917, where they were reported as gnawing the leaves badly, and as being very difficult to destroy with the customary doses of arsenate of lead.

We were made to realize keenly the defects in our nursery inspection law recently by a sudden demand for a quarantine against the white pine blister rust. The Kentucky law makes no provision for quarantines, and in fact does not provide for any rules or regulations by any state official under which a quarantine may be established. With a federal quarantine of territory of which Kentucky is a part, state legislation is not now so badly needed, but we should have been able to act at once. The law needs amending to provide for such emergencies.

American foulbrood is giving us much trouble, especially about the edges of cities where a good many people keep bees, but handle them badly. The spread of the disease among such beekeepers is rapid and in many cases results in a complete extermination of the colonies. The inspection of apiaries will some day be demanded by our people. The rapid growth of interest in beekeeping in the state, and the pronounced success of some of our commercial apiarists and queen rearers, is calling attention to this need, and we expect it to result soon in a good law with ample provision for enforcing it.

It may be of interest to collectors of Coleoptera to know that the introduced Tenebrionid (*Blaps mucronata*) has recently appeared in some numbers in grain warehouses at Lexington. Dozens were secured January 20, 1916, in the basement of a seed warehouse under sacks and among grain refuse about the floors. It was subsequently found about a dump at the edge of Lexington where it had probably been thrown with refuse from buildings. The first specimens observed here were collected in 1914. We cannot see that it is doing serious mischief, though it feeds on grain. The eggs and larvæ have been secured, but have not yet been followed to maturity.

The wheat fly (*Oscinis variabilis*)[1] emerged in one of our cages this spring, May 2, developing from wheat planted October 2, 1916, taken up last fall and kept out of doors at Lexington until the insects ap-

[1] When it was first discovered on wheat in Kentucky the writer did not feel satisfied that it was Loew's *O. variabilis* for the reason that it did not agree well with his description. Professor Aldrich, in his List, placed it under *O. carbonaria* Loew, though apparently with some doubt. He has recently examined some of my material and now pronounces it *O. pusilla* Meigen.

peared. It would seem, therefore, that its eggs may be laid very late in the fall.

We are still working on the locust borer (*Cyllene robiniæ*) and have some problems connected with its injuries and ecology to work out during the season now opening.

AN APHIS PARASITE FEEDING AT PUNCTURE HOLES MADE BY THE OVIPOSITOR

By L. P. Rockwood, *U. S. Bureau of Entomology, Forest Grove, Oregon*

Having had my attention called by Dr. L. O. Howard to the fact that probably no observation has yet been published on any parasite of an aphis feeding on the juices of the host at puncture holes made by the ovipositor, I present the following observation as of interest for this reason.

On September 8, 1916, while examining red clover stems infested with *Aphis bakeri* Cowen, an *Aphelinus*, previously reared from this aphis and recently described by Dr. L. O. Howard in the Proceedings of the Biological Society of Washington, vol. 30, p. 77, as *Aphelinus lapisligni* n. sp., was found in the midst of a colony of *A. bakeri* beneath a bract on a clover stem. The *Aphelinus* was observed to approach a medium-sized aphis which was feeding. The parasite examined the aphis with its antennæ, then walked away about its own length, turned its back to the aphis and exserted its long semi-transparent ovipositor which it plunged into the aphis, a little to one side of the anus. The *Aphelinus* kept its ovipositor inserted during a space of several seconds, and during that time backed up toward the aphis, apparently plunging the ovipositor deeper into the wound. The aphis showed some discomfort and excreted a drop of honey dew from the anus. The parasite concluded its operation, walked off a few of its own lengths and returned to repeat the performance during a much shorter period. The operation was repeated three times while under observation, the ovipositor being inserted each time in approximately the same place. Then the *Aphelinus* returned and placed its mouth to the wound, and apparently fed on the juices of the aphis for more than a minute. The aphis was not dissected so it is not known whether one or more eggs were laid in the aphis.

For instances of this feeding habit with other parasitic Hymenoptera and other hosts, consult the paper entitled "On the Habit with Certain Chalcidoidea of Feeding at Puncture Holes made by the Ovipositor," by L. O. Howard, Journal of Economic Entomology, vol. III, No. 3, June, 1910, pages 357–360.

EASTERN APHIDS, NEW OR LITTLE KNOWN, PART I[1]

By Edith M. Patch

The present paper resulted from the examination of the collection of Connecticut aphids lent by Dr. W. E. Britton. Several undescribed species were found, some of which were well known in certain collections without having made their way into literature. A few of these are briefly described by the writer of Part I, and the others are presented by Mr. Baker in Part II as he was already at work on the groups those species represent, and kindly undertook their examination.

Most of the species are described with reference to material from Connecticut, though a few not yet reported from that state are included.

Aphis viburniphila n. sp.

(Fig. 20, c, d, e)

Alate Vivipara: Head, eyes, and antenna black, antennal joint III and VI approximately same length and sub-equal to IV + V, III with about 20 sensoria extending whole length, IV with from none to several sensoria, beak extends to second coxæ; thorax black, prothoracic tubercles prominent, wings with rather heavy dark veins; abdomen glabrous, dark red to reddish brown both above and beneath, caudal portion black, four lateral dusky spots cephalad of the cornicles, cornicles cylindrical, black, about twice the length of tarsi, imbrications serrate; cauda and cornicle, black, paler at base; lateral tubercles present, that between cornicle and cauda being prominent.

Apterous Vivipara: Head black, antenna dark except proximal III which is pale, III with about 15 sensoria which are more numerous on distal half, IV with or without sensoria; thorax reddish brown with prothoracic tubercles: abdomen bright reddish brown with two transverse black stripes cephalad the cauda, cornicles and cauda black.

Apterous Ovipara: Tan-colored form with black cornicles which are slightly more than half as long as in the apterous vivipara; antenna without secondary sensoria; hind tibia but slightly enlarged with a very few sensoria on distal half.

The cotype localities are Orono, Maine, where the writer has collected this interesting aphid for ten years; New Haven, Connecticut, where it has been taken by Dr. W. E. Britton and Mr. H. D. Clark; and Plummer's Island, Maryland, and Great Falls, Virginia, where Mr. W. L. McAtee has collected it, specimens from all these places being examined at time of preparing the description. Mr. J. J. Davis writes (March 22, 1916) that he has this species from St. Louis, and from Chicago where it is sometimes a serious pest of the *Viburnum* in parks.

In Maine this species is present on *Viburnums* during the entire year, being conspicuously abundant during June, July and August. It

[1] Papers from the Maine Agricultural Experiment Station: Entomology No. 88.

attacks cyme, both during flower time and early fruiting, ventral leaves and the tender twigs. The insects are gregarious and their colonies are frequently wellnigh exterminated by hymenopterous parasites. It is sometimes present on the same *Viburnums* with *Aphis viburnicola* Gillette, *A. rumicis* Linn, and *Macrosiphum viticola* Thomas, but there is no need of confusing it with any of these species.

On August 24, 1912, and August 26, 1915, at Orono oviparous females were found to be numerous feeding at berry clusters and depositing eggs thickly in axil of leaf and between terminal stems. Males have not yet been recorded. The time of the hatching of the stem female has not been observed.

The writer has seen specimens from *Viburnum acerifolium* L., Maine and Maryland; *V. cassinoides* L., Maine; *V. dentatum* L., Maine and Virginia; *V. opulus* L., Maine and Connecticut; *V. plicatum*, Connecticut; *V. pubescens* Pursh, Maryland.

Aphis rumexicolens n. sp.

(Fig. 20, f, g)

Alate Vivipara: Antenna 6-jointed, on no frontal tubercle, III with about 14 sensoria irregularly placed along whole length, V shorter than IV, VI longer than III; beak short, not or scarcely reaching second coxa; venation rather heavy but not shadowed; abdomen with black dorsum and large black lateral spots, cornicle shorter than tarsus or cauda, slightly bulging; cauda broad and blunt, about the length of tarsus but up-turned and appearing shorter, with a pair of dorsal tubercles near base.

Apterous Vivipara: Antenna 6-jointed, III without sensoria, base of VI subequal to V; beak short not reaching second coxa: abdomen not showing in alcoholic mount the black maculations of the alate form, cornicle shorter than tarsus, not longer than base of VI, thick at base and abruptly narrowing, tip with flare.

The cotype locality is Wallingford, Connecticut, where a collection of apterous and alate vivipara and pupal nymphs was made June 9, 1913, from *Rumex acetosella* L., by Dr. W. E. Britton.

It is needless to say that this is no typical *Aphis*, but it does not seem to slip into any of the several genera newly erected from *Aphis* and the writer hesitates to contribute to the modern tendency of establishing new genera on specific characters,—a conservatism which has disadvantages of its own, it must be confessed.

Aphis saliceti Kaltenbach

(Fig. 20, a, b)

This insect has not previously been recorded for America. It was collected at Orono during late June and July, being abundant upon fennel (*Foeniculum vulgare*), July 25 upon *Heracleum lanatum*, and August 12 upon cultivated parsnip in 1913. The same year it was taken on cultivated parsnip July 25 at Machias, Maine, and on willow

(*Salix sp.*) July 30 at Cherryfield, Maine. Specimens have recently been submitted to the writer for determination which were collected from parsnip at New Haven, Connecticut, July 13, 1909, by Mr. A. I. Bourne.

The willow seems to have been the only host previously known for this species. That it accepts members of the *Umbelliferae* also is evident from these collections but the details of its life-cycle have not been worked out. This is "*A. saliceti* Kalt." of Buckton and of Theobald 1912, but evidently not of all writers.

Aphis davisi, new name

It seems necessary at this time to rename the aphid recorded as *Aphis populifoliæ* Fitch by Mr. Davis (Journal Economic Entomology, vol. 3, p. 489) as, according to Mr. Baker, *populifoliæ* Fitch belongs under *Pterocomma*.

Prociphilus xylostei de Geer
(Fig. 20, h, i)

A colony of what seems to be the first collection of this species for America was taken from *Lonicera* at Orono, Maine, July 7, 1914. A single stem female with her progeny of pupal nymphs and newly winged spring migrants were collected. The migrants apparently accord in structural characters with specimens of this species taken in Sweden by Albert Tullgren, and seen by the writer, though they are smaller.

Prociphilus approximatus n. sp.

Alate Vivipara: Head with dorsal wax plates large, sub-circular and separated by fully half their width; beak extending to or a little beyond second coxæ, antennal segment III with $\pm$ 25 sensoria, IV with $\pm$ 8, V with $\pm$12, VI with $\pm$12, IV about as long as tarsus exclusive of claw, shorter than V or VI which are sub-equal, III a little longer than V + VI; thorax with wax plates large, clear cut, approximate, being separated only by a straight line; wings not unusual for this genus; abdomen with large lateral wax plates covering nearly the width of the segment, and large dorsal wax plates.

The cotype material including pupæ and newly molted alates was collected from White Ash, Hawleyville, Connecticut, June 19, 1914, by Dr. W. E. Britton. It is a distinctive species especially with reference to the large approximate thoracic wax plates, and if migratory offers an interesting life-cycle problem.

Lachnus rosæ Cholodkovsky
(Fig. 20, j)

A *Lachnus* which accords too well with the species indicated to entitle it to another name was made July 12, 1915, from wild rose near

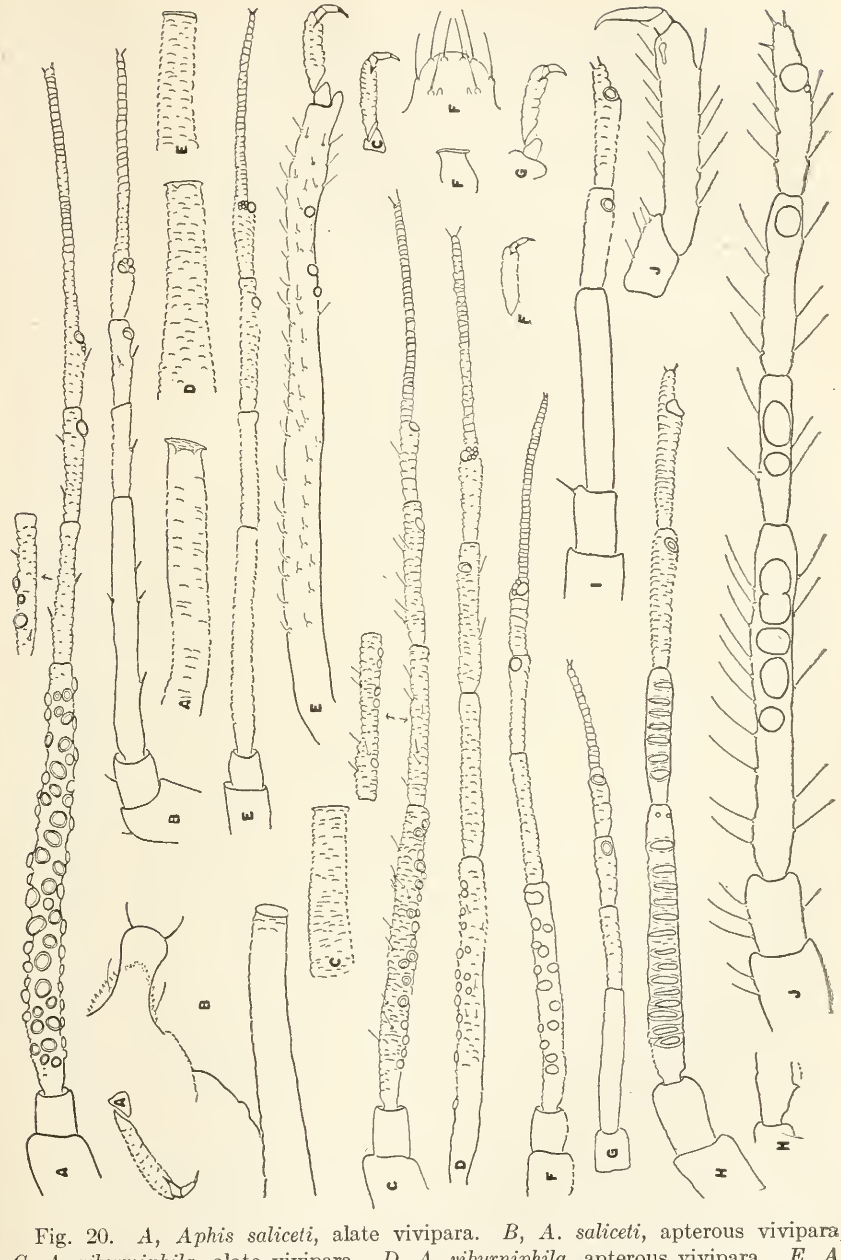


Fig. 20. *A, Aphis saliceti,* alate vivipara. *B, A. saliceti,* apterous vivipara, *C, A. viburniphila,* alate vivipara. *D, A. viburniphila,* apterous vivipara. *E, A. viburniphila,* apterous ovipara. *F, A. rumexicolens,* alate vivipara. *G, A. rumexicolens,* apterous vivipara. *H. Prociphilus xylostei,* alate vivipara. *I, P. xylostei.* apterous vivipara. *J, Lachnus rosæ,* alate vivipara.

Orono. The colony was feeding on the stem and was accompanied by ants. Alate and apterous females and nymphs were taken at this time. Later, August 24, in the same locality an apterous female and nymph of this aphid were found. The body of the apterous female was glistening bronze and thickly hairy. The nymph was cinnamon brown. This has not been compared with actual specimens from Russia, but the figures accompanying the original description seem in this case adequate for determination. There is no previous record of this species for America.

EASTERN APHIDS, NEW OR LITTLE KNOWN, PART II

By Arthur C. Baker, *Bureau of Entomology, Washington, D. C.*

Genus Myzocallis Pass

Myzocallis punctatellus (Fitch). (1855, p. 165.) This species has been placed as a synonym of *caryella* by Oestlund (1887, p. 45). The type specimen which is in the U. S. National Museum collection proves this not to be the case. The type is not in perfect condition, having lost the abdomen, one antennæ, the unguis of the other and both hind wings. However, enough of the specimen remains to make a determination positive and this remnant has been well mounted by Mr. Pergande. The antenna remaining on the type measures as follows: III, 0.592 mm.; IV, 0.496 mm.; V, 0.368 mm. Segment III is armed with seven rather large sensoria forming a row along the segment. The vertex and crown are armed with a number of tubercles on which spines are mounted. The wings are without markings excepting a clouding around the edge of the stigma and bands of brown bordering the veins. This bordering of the veins is rather faint in the type which is no doubt somewhat faded.

Mr. Davis kindly sent me specimens of an undescribed species from the Monell collection. These specimens, No. 370 X, are undoubtedly *punctatellus*. The banding along the veins is more distinct and the specimens are in good shape. They are alate viviparous females. The following description is drawn up from the specimens.

Alate Viviparous Female: Antennæ as follows: III, 0.576 mm.; IV, 0.432 mm.; V, 0.336 mm.; VI (0.144 mm. + 0.32 mm.). Segment III, with usually five large circular sensoria in a row. Labium short. Abdomen with two pairs of very prominent finger-like tubercles and with several smaller ones. Length of the larger pair of these tubercles about 0.16 mm. Cornicles about 0.065 mm. Length of fore wing 2.56 mm. Length from vertex to tip of cauda 1.44 mm.

General color pale yellowish. Antennal segments ringed with brown at their distal extremities; tarsi, abdominal tubercles and a spot near the distal extremity of the femora dark brown; wings banded with brown as previously described.

A form occurs in a collection taken on oak at New Haven, Conn., June 27, 1913, by H. L. Trowbridge, on oak, New Haven, Conn., July 25, 1912, by J. K. Lewis, and in a collection taken on oak at Vienna, Va., August 23, 1912, by the writer. This form agrees with the specimens mentioned previously in all details excepting the markings of the wings. It is true that larger or smaller specimens show longer or shorter antennæ, but this might be expected. Among the specimens in these collections great variation is met with in the markings of the wings. In several specimens the markings have a tendency to be arranged along the veins. From this fact and the very close measurements and structural details the writer feels that the specimens may all represent the same species. He is, therefore, calling them *punctatellus*. Abundance of material may, however, prove two species present.

Myzocallis alnifoliæ Fitch. (1851, p. 67.) This species occurs throughout the Eastern States on alder and is recorded in our literature as *alni* Fab. The European insect seems to be different from our form and this is shown particularly in the oviparous female. In specimens of the oviparous female of *alni* determined by Schouteden the third segment of the antennæ is armed with prominent hairs. The other segments sometimes also have them although no sensoria are met with on the antennæ. The hind tibiæ are swollen and covered with numerous sensoria as is usual with many of such forms. *Alnifoliæ* on the other hand has no such prominent hairs on the antennæ of the oviparous forms. The third segment, however, is armed with several sensoria in all adult specimens examined by the writer. These two differences would seem to indicate that the American form is distinct from the European.

The types of *alnifoliæ* have seemingly been lost. It is most probable that they were destroyed during the years between Fitch's death and the time his collection was brought to Washington. In looking over the Fitch collection the writer found the positions in which the specimens were pined, but the specimens have disappeared. It would appear, therefore, that the determination can never be positively proven. The description, however, fits the insect well. In his notes Fitch first described the species as *Aphis alnicolens*, which name he afterwards changed. In his collection there were no specimens bearing this name.

Myzocallis californicus n. sp. Taken on *Quercus lobata* Nee, Walnut Creek, Cal., April 6, 1916, by W. M. Davidson. Although not a Eastern species the present form is here described in order that it may be included in the key of American species of the genus. It seems to be somewhat related to *fumipenellus* Fitch.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Antennæ with the following measurements: Segment III, 0.72 mm.; IV, 0.432 mm.; V, 0.352 mm.; VI (0.144 mm. + 0.16 mm.). Segment III is armed with about 4 circular sensoria considerably separated. Abdomen armed with three pairs of prominent finger-like tubercles tipped with stout hairs. Cornicles rather long and narrow for the genus, 0.112 mm. long. Cauda quite deeply bilobed, suggesting that of *fumipenellus* Fitch; cauda very distinctly knobbed. Length of forewing, 2.4 mm.; length from vertex to tip of cauda about 1.7 mm.

Color Characters: General color pale yellowish green; eyes, distal extremities of the antennal segments, the tarsi, a spot on the proximal extremities of the tibiæ and a small area on each end of the tibiæ brown. Otherwise uniform yellowish green, the eyes of the embryos showing through the abdomen as small red spots.

Described from alate viviparous females in balsam mounts.

Type in U. S. National Museum. Cat. No. 20341.

Myzocallis fumipennellus (Fitch). (1855, p. 166.) This seemingly rare species is known to the writer only from the type now in the National Museum and from the type of *caryæfoliæ* Davis, in the same collection. The two seem to be identical. Fitch's type is not entire but consists of the head and thorax with the third segment of one antenna and part of the other, the wings and the legs. The abdomen of course is shrunken. The parts remaining, however, are very characteristic and leave little doubt that the species described by Davis is the *fumipennellus* of Fitch.

Wilson placed this species in the genus Callipterus as the only American form. It is quite distinct, however, from the type of the genus, and is no doubt a *Myzocallis*. So far as the writer is aware no species of Callipterus occur in this country.

The excellent description given by Davis (1910, p. 198) has placed this species definitely in the literature and it only remains to transfer Fitch's name to his description.

Myzocallis tiliæ (L). Taken on *Tilia*, New Haven, Conn., July 14, 1909, by A. I. Bourne. Conn. No. 1–16/109. This well-known species seems to occur commonly wherever its host tree is grown. The genus Eucallipterus has been erected with this form as type. There is no doubt that the species considered without other forms shows a considerable difference from the type of Myzocallis. Three species might be separated and included in *Eucallipterus; tiliæ* L., *bellus* Walsh and *walshi* Mon. The only real character to separate *tiliæ* is the deeply bilobed nature of the anal plate as compared with the shallow bilobed anal plate of Myzocallis. Some species of Myzocallis, as *trifolii* Mon., often have a distinctly bilobed anal plate. The cauda and anal plate of *bellus* Walsh are very close indeed to those of *tiliæ* and there would be no difficulty in separating these two species from the type of Myzocallis. *Walshi* Mon. is very close in general structure to *bellus* Walsh; so close indeed, that it has by some been placed as a

synonym. Yet when we come to examine the anal plate of *walshi* we find that many specimens show a typical Myzocallis anal plate. The prothorax in *tiliæ* is somewhat different from that of most species of Myzocallis and this is also approached by *bellus* and *walshi*. Yet other species vary toward it. Here then we have the choice of placing *tiliæ* and *bellus* in Eucallipterus and most specimens of *walshi* in Myzocallis or of transferring *tiliæ* to Myzocallis wherein *bellus* was described and the other species since placed. The latter method has been adopted by the writer in that it would seem to simplify matters. The species needs no descriptive remarks since an excellent description has been given by Davis. (1909, p. 33.)

The following key will distinguish the American species of Myzocallis.

Key to American Species of Myzocallis

(Alate viviparous females)

1. Dorsum of abdomen with finger-like tubercles 2
   Dorsum of abdomen without such tubercles 7
2. Unguis of segment VI about equal in length to the base 3
   Unguis of VI twice as long as base . . . . *punctatellus* (Fitch)
3. Cornicles long (nearly 0.112 mm.) abdomen greenish 4
   Cornicles short (0.064 mm. or less) 5
4. Segment VI less than width of head across eyes . . . . *californicus* Baker
   Segment VI much longer than width of head across eyes . . . . . . *pasaniæ* Davidson
5. Segment III of antennæ shorter than the width of head across eyes, abdominal tubercles setose and dark brown; cornicles about 0.06 mm. *fumipennellus* (Fitch)
   Segment III longer than width of head across eyes 6
6. Cornicles about 0.06 mm. long and black . . . . *quercus* (Kalt.)
   Cornicles about 0.032 mm. long and not black . . . . *ulmifolii* (Mon.)
7. Entire margin of wing with a rather broad dark brown band 8
   Margin of wing without such dark brown band 10
8. Unguis of segment VI more than twice as long as base, hind tibiæ yellowish *walshi* (Mon.)
   Unguis of segment VI less than twice as long as base 9
9. Antennæ distinctly annulated with dark brown; segment III with 10 to 12 oval sensoria, tips of the wing veins marked with brown . . . . *tiliæ* (L.)
   Antennæ uniform yellowish or dusky; segment III with about four circular sensoria; tips of wing veins not marked with brown . . . . *bellus* Walsh
10. Unguis of segment VI about equal to or less than the length of the base 11
    Unguis of segment VI considerably longer than the base 14
11. Abdomen with a number of dark spots 12
    Abdomen uniform green or yellowish green 13
12. Antennæ annulated, segment III with 4 to 8 sensoria close to base of segment *arundicolens* (Clark)
    Antennæ yellowish or dusky; segment III with a row of 10 or 12 sensoria covering about three-quarters of the segment . . . . *trifolii* (Mon.)
13. Anal vein and base of cubitus and of media much heavier than the other veins of the wing . . . . *alnifoliæ* (Fitch)
    Venation nearly uniform . . . . *robiniæ* (Gill.)

14. Wings more or less banded or mottled with dark brown 15
    Wings not so banded or mottled 16
15. Cornicles and a patch around their bases black.................. *discolor* (Mon.)
    Cornicles and a patch around their bases yellow............. *asclepiadis* (Mon.)
16. Unguis of segment VI three times as long as base................ *coryli* Gœtz
    Unguis of segment VI about twice as long as base 17
17. Abdomen with four rows of dark brown markings .... *castanicola* Baker
    Abdomen without dark brown markings.................... *punctatus* (Mon.)

N. B. *Callipterus genevii* Sanb. is a synonym of *trifolii* Mon.
Callipterus hyalinus Mon. is a synonym of *punctatus* Mon.
Callipterus castaneæ Buckton has been renamed *castanicola* n. n. Baker

Genus Monellia Oest.

Monellia costalis (Fitch). (1855, p. 165.) Taken on hickory leaves, New Haven, Conn., June 27, 1910, by W. E. Britton. Conn. No. 1–16/70.

In order to determine positively whether or not the specimens collected are this species the writer examined the Fitch collection and located the type specimen still bearing the original number mentioned in Fitch's note book. Since there was only one specimen in Fitch's collection and one specimen only referred to in his notes, there can be positively no doubt about this specimen being the type. Descriptive notes follow:

Alate Viviparous Female: Antennal segments as follows: III, 0.352 mm.; IV, 0.256 mm.; V, 0.256 mm.; VI (0.16 mm. + 0.176 mm.). Segment III with five or six oval sensoria on the swollen 0.128 mm. of the segment. Abdomen with three rather large rounded gibbous tubercles on each side of abdomen. Length of forewing 1.144 mm. Length from vertex to tip of abdomen 1.76 mm.

Color yellowish; antennæ yellow ringed with dark brown; vertex lined with dark brown and a line extending down each side from eyes to past the caudal pair of the lateral tubercles mentioned. Fore wings with a broad brown band extending along the costal margin to beyond the stigma, this band interrupted just mesad of the stigma.

Key to the American Species of Monellia

(Alate viviparous females)

1. Costal margin of wing with a broad brown band extending beyond the stigma, tibiæ yellow, antennæ annulated with brown................. *costalis* (Fitch)
   Costal margin of wing without such broad band though in some cases with the costal vein brown 2
2. Tibiæ, antennæ and costal vein dark brown to black......... *californica* Essig
   Tibiæ and costal vein yellowish, antennæ annulated with dark brown........ 3
3. Abdomen with rows of dark brown spots; the unguis of Segment VI of antennæ longer than or equal to the base............................. *caryæ* (Mon.)
   Abdomen without such spots; the unguis of segment VI of antennæ considerably shorter than the base.............................. *caryella* (Fitch)

Genus Euceraphis Walker

Euceraphis betulæ (Koch). Taken on Japanese maple, Hartford, Conn. Sept. 11, 1905, by C. N. Ruedlinger, Conn. No. 1–16/145.

This species may be distinguished by the black marking upon the abdomen, the wax pores, the color of the legs and the proportions of the antennal segments and the width of the head.

The abdomen of the alate vivipara is marked with a large quadrate more or less broken dark brown patch. Within this patch there are lighter somewhat oval areas which constitute the wax plates. These areas are composed of small circular pores very variable in number in the different plates. The hind tibiæ are light in color with the distal extremities and tarsi black. The antennal segments measure as follows: III about 1.456 mm.; IV, 1.008 mm.; V, 0.8 mm.; VI (0.256 + 0.256 mm.). The head is about 0.6 mm. in width across the eyes.

Dr. Fitch described a member of the present genus under the name of *Aphis cerasicolens*. (1851, p. 65.) The type of this species is not in good condition. It was mounted from the Fitch collection by Mr. Theo. Pergande. As far as the writer is able to tell from an examination of the specimen this name is a synonym of *betulæ*.

Euceraphis mucidus (Fitch). (1856, p. 334.) Taken on black birch, New Haven, Conn., July 1913. Conn. No. 1–16/19.

The writer has examined the specimens of this species from the Fitch collection and compared them carefully with the Connecticut material and specimens from other regions. He is thus able to give a positive determination.

Alate Viviparous Female. Morphological Characters: Antennæ about as follows though somewhat longer or shorter in larger or smaller specimens. Segment III, 1.984 mm.; IV, 1.408 mm.; V, 1056 mm.; VI (0.448 mm. + 0.384 mm.). Segment armed with a few short, stiff, spine-like hairs. Segment III, with about 30 narrow oblong transverse sensoria upon the basal half of the segment. The extreme basal portion is without sensoria and that part which is covered with sensoria is somewhat swollen. Distal segments rather strongly imbricated; width of the head across the eyes about 0.64 mm.; vertex with a few short spine-like hairs and somewhat projecting forward to the median ocellus but without tubercles or projecting areas above. Cornicles nearly 0.16 mm. long and about 0.117 mm. broad at the base. Anal plate slightly notched; tibiæ very thickly covered with minute subcircular pore-like areas which are hardly as large as the tubercles forming the bases of the hairs on these segments. Dorsum of abdomen without apparent wax gland areas. Length from vertex to tip of cauda 2.88 mm.

Color Characters: Antennæ uniform black. In the pupa some specimens show only the distal segments black. Body pale green. Abdomen without the black markings met with in *betulæ*. Wings transparent, the veins sometimes noticeably dark brown. Stigma bordered below usually with dark brown or black. Femora whitish, tibiæ and tarsi black.

Body covered with a thick powdery material. Legs and sometimes parts of body covered with flocculent mealy down which assists the insect in floating through the air.

Besides the proportions, the distinguishing characters of this species are the uniform black antennæ and the absence of markings upon the abdomen. The most important character, however, is nature of the tibiæ. What appears to be the same species as *mucidus* was described by Fitch as *Aphis pinicolens.* (1851, p. 66.) The type of this species in the U. S. National Museum is in very poor condition. The tibiæ show the large number of minute pore-like structures met with in *mucidus.* The tibiæ, however, are not uniform black as in the type of *mucidus* and in the collected material of that species. Only their tips are dark brown. This may be due to the fading of the type specimen. No collected specimens which agree in all details with this type of *pinicolens* have been seen by the writer. He therefore withholds judgment in regard to the use of the name *pinicolens.*

Euceraphis brevis n. sp. Taken on "cut-leaf" white birch, Middletown, Conn., May 3, 1906, by Morris B. Crawford, Bureau of Entomology No. 9541, and on Betula sp., Ithaca, N. Y., May 15, 1911 by E. M. Patch, Me. Exp. Sta. Acc. No. 20–11.

Alate Viviparous Female: Morphological Characters: Antennal segments as follows: III, 1.2 mm.; IV, 0.672 mm.; V, 0.528 mm.; VI, (0.176 + 0.128 mm.). Segment III, with 18 or 20 sensoria close together upon the basal third of the segment. Distal segments imbricated; width of head across the eyes about 0.64 mm.; vertex with two slight projections above abdomen with large lateral protuberances. Cornicles about 0.128 mm. long. Anal plate entire; length from vertex to tip of cauda 2.4 mm.

Color Characters: General color greenish; antennæ shaded with dusky becoming black on the distal segments; legs with the tarsi and distal extremities of the tibiæ black. The distal extremities of the femora are also sometimes more or less black.

Described from alate viviparous females in balsam mounts.

Type in U. S. National Museum. Cat. No. 20342.

Euceraphis lineata n. sp. Taken on birch at Durham, N. H., Oct. 19, 1903, by C. M. Weed, Bureau of Entomology No. 9315 D., and on *Betula populifolia*, Orono, Me., July 21, 1906, by E. M. Patch, Me. Acc. No. 83–06.

Alate Viviparous Females: Morphological Characters: Antennæ with the following measurements: Segment III, 1.68 mm.; IV, 1.36 mm.; V, 0.928 mm.; VI (0.096 mm. + 0.4 mm.). Segment III with about 25 sensoria on the basal 0.64 mm. Width of head across the eyes 0.64 mm.; vertex without projections, antennæ rather close together. Length from vertex to tip of cauda 3.12 mm.; length of forewing 4.5 mm.; anal plate rounded or very slightly indented.

Color Characters: General color greenish yellow; antennæ dusky with blackish distal annulations on the segments; tarsi, distal extremity of labium and distal extremity of the femora and tibiæ dark brown. The tibiæ has, moreover, a longitudinal dark brown stripe extended for nearly its entire length. Abdomen without dark brown markings but with the eyes of the young showing as dark brown spots.

Described from specimens in balsam mounts.

Type in U. S. National Museum. Cat. No. 20343.

Euceraphis deducta n. sp. Taken on birch, Orono, Me., June 12, 1907, by E. M. Patch, Me. No. 4–07.

This species is easily distinguished from all others in the genus by the proportions of segment VI of the antenna.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Segment III, 1.68 mm.; IV, 0.88 mm.; V, 0.8 mm.; VI (0.48 mm. + 0.144 mm.). Segment III, with about 20 sensoria on the basal 0.56 mm. Width of head across the eyes 0.64 mm. Cornicles and anal plate normal for the genus. Length from vertex to tip of cauda 2.4 mm. Length of forewing 3.52 mm.

Color Character: Color apparently a uniform yellowish green. Antennæ, tips of femora and tibiæ and the tarsi dusky. Eyes dark brown; wings unmarked excepting the tips of the veins which are shaded with brown.

Described from specimens in balsam mounts.

Type in U. S. National Museum. Cat. No. 20344.

The following key will distinguish the American species of Euceraphis.

KEY TO THE AMERICAN SPECIES OF EUCERAPHIS

(Alate viviparous females)

1. Anal plate distinctly but not deeply bilobed. Segment III of antennæ with eight or nine sensoria . . . . *flava* Davidson
   Anal plate entire or but slightly indented 2
2. Tibiæ uniform black and covered thickly with a large number of small clear pores . . . . *mucidus* (Fitch)
   Tibiæ not uniform black and without such pores 3
3. Abdomen with a large dark brown patch in which are clear wax pore areas *betulæ* (Koch)
   Abdomen without such dark patch and wax pore areas 4
4. Combined length of base and unguis of segment VI about equal to half of the diameter of the head across the eyes . . . . *brevis* Baker
   Combined length of the base and unguis of segment VI about equal to or much more than the diameter of the head across the eyes 5
5. Unguis of segment VI less than one third of the length of the base . . . . *deducta* Baker
   Unguis of segment VI considerably more than two-thirds as long as the base . . . 6
6. Hind tibia with a longitudinal black stripe on its outer edge; segment III with about twenty-five sensoria . . . . *lineata* Baker
   Hind tibia with only the distal extremity black and segment III with about fifteen sensoria . . . . *gillettei* Davidson

GENUS CALLIPTERNELLA Goot.

Callipternella annulata (Koch). Taken on *Betula populifolii* at Veazie, Me., by E. M. Patch, July 22, 1909. Maine No. 82–09. On white birch, New Haven, Conn., July 7, 1909, by A. I. Bourne, Conn. No. 1–16/142. On birch, New Haven, Conn., by A. B. C., June 28, 1911, Conn. No. 1–16/18 and on birch at Madison, Wis., by J. J. Davis, June 7, 1913. What is evidently the same species was mentioned by Gillette (1910) as occurring upon Birch. Vander Goot (1913, p. 113) has placed this form as the same species as *annulatus* Koch.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Antennæ measurements as follows: I, 0.08 mm.; II, 0.048 mm.; III, 0.48 mm.; IV, 0.288 mm.; V, 0.176 mm.; VI, (0.096 + 0.24 mm.). Segment III, armed with from 5 to 7 circular sensoria in an even row on the basal two-thirds of the segment. The sensorium at the base of the unguis of VI, rather elongate, all permanent sensoria fringed; vertex somewhat protruding and armed with prominent hairs about 0.08 mm. long. Cornicles about 0.08 mm. long, distinctly imbricated but not reticulated. Wings usual, forewing about 2 mm. long and with the radial sector faintly indicated or almost absent. Length from vertex to tip of cauda about 1.54 mm.

Color Characters: Antennæ yellowish with the base, the distal segments and the distal extremities of III and IV brown; legs, cornicles, transverse bands and lateral spots on the abdomen dark brown to black. Wing veins faintly bordered with dusky; stigma dusky with a clear central area.

APTEROUS VIVIPAROUS FEMALE: Morphological Characters: Antennal measurement as follows: I, 0.064 mm.; II, 0.048 mm.; III, 0.48 mm.; IV, 0.24 mm.; V, 0.224 mm.; VI (0.096 + 0.304 mm.). Segment III, with about 8 circular sensoria in a row on the basal two-thirds of the segment. Hairs on the vertex about 0.15 mm. long. Cornicles about 0.096 mm. long, imbricated, not reticulate. Length from vertex to tip of cauda about 1.92 mm. Abdominal hairs of about equal length with those on the vertex. Dorsum of abdomen covered with minute projections giving it an almost granular appearance.

Color Characters: General appearance dark brown. Antennal segments III and IV with dark distal extremities, the distal portions of the antennæ entirely dark. Legs dark brown. Head and thorax with large dark brown area. Abdomen marked with large dark brown lateral patches and with transverse dorsal bands of dark brown one on each segment. Remainder yellowish.

GENUS CHAITOPHORUS Koch.

Chaitophorus lyropicta Kess. Taken on the Norway maple, Meriden, Conn., June 26, 1912, by Louis A. Guidebrod. Conn. No. 1–16/14.

This species is abundant upon the Norway maple throughout the eastern section of the United States. The insect is usually considered in America under the name of *aceris*. It may be distinguished by the proportions of the sixth segment of the antennæ. The species varies considerably in size; the antennæ of the alate vivipara averaging about as follows: III, 0.592 mm.; IV, 0.368 mm.; V, 0.32 mm.; VI (0.112 mm. + 0.512 mm.). Segment III is armed with a more or less even row of from 4 to 9 sensoria.

So far as the writer has been able to discover this species never produces dimorphs.

Chaitophorus americanus n. sp. Taken on sugar maple, Brookfield Center, Conn., May 10, 1913, by C. Holder; Conn. No. 1–16/13, on *Acer* sp., Orono, Me., June 1, 1909, by E. M. Patch; Me. No. 18–09 on *Acer circinatum* at Hoquiam, Wash., June 1903, by A. D. Hopkins and on the same tree at Hoquiam, Wash., August 1903, by H. E. Burke, Bureau of Entomology, No. 9797.

There seems to have been considerable confusion in regard to the species of Chaitophorus producing dimorphic forms. Two species

occur in Europe and two in America. The European species are *aceris* L. and *testudinatus* Thorn. Of these the latter species has dimorphs margined with lamellæ whereas the dimorphs of *aceris* are armed only with long stout hairs. The two species in this country *negundinis* Thos., and the present one both have dimorphs margined with lamellæ. *Negundinis* is found upon the Manitoba maple (*Acer negundo*), whereas *americanus* feeds on the trees mentioned previously. The two species are easily distinguished.

Alate Viviparous Female: Morphological Characters: Antennæ showing considerable variation, but being about as follows: Segment III, 0.72 mm.; IV, 0.44 mm.; V, 0.34 mm.; VI (0.128 mm. + 0.368 mm.). Segment III, armed with from 18 to 24 irregularly placed sensoria which often give the segment a more or less swollen appearance. Antennal hairs long and prominent; about 0.16 mm. on Segment III. Cornicles about 0.24 mm. long and covered with reticulate areas; length from vertex to tip of cauda 3.1 mm.

Color Characters: General color dark green. Head, antennæ, thoracic lobes, sternal plate and cornicles black. Abdomen with a row of transverse black bands on the dorsum and with a row of more or less circular black spots along the margin.

Dimorph: Morphological Characters: Antennal segments as follows: III, 0.16 mm.; IV (0.064 mm. + 0.24 mm.). First segment large, projecting forward; vertex and entire margin of the body with the exception of the lateral margins of the head covered with a row of lamellæ. On the lateral margins of the head the lamellæ are replaced by lanceolate spines. Similar spines also occur upon the outer margins of the legs; dorsum apparently without plate-like structures.

Color Characters: Pale greenish with red-brown eyes.

Described from specimens in balsam mounts. Type in U. S. National Museum. Cat. No. 20345.

Chaitophorus viminalis Mon. (1879, p. 31.) Taken on *Populus grandidentata*, New Haven, Conn., June 29, 1914, by M. P. Zappe. Conn. No. 1–16/24.

A study of the type of this species kindly sent to the writer by Mr. J. J. Davis, and numerous specimens from different localities proves that the species always possesses a granular surface on the skin, although this granulation varies considerably in degree. The color also varies from a light green to a dark brown.

Chaitophorus nigræ Oest. (1887, p. 40.) Taken on willow at Galesville, Conn., July 15, 1909, by B. H. Walden. Conn. No. 1–16/125.

In studying a series of specimens thought to be this species it was noted that the reticulate marking of the skin was a constant character. Professor Oestlund kindly examined his type and informed the writer that this character is present in the type. It seems, therefore, that *nigræ* may be separated from *viminalis* on this character and on the sensoria. The type of *cordata* Wms., proves it to be the same species.

Chaitophorus bruneri Wms. (1910, p. 25.) Taken on poplar,

New Haven, Conn., July 8, 1909, by A. I. Bourne. Conn. No. 1–16/132.

This species is very close indeed to *populicola* Thos., as that insect is at present understood. A large series of the latter species shows considerable variation and a more thorough study should be made of bred material. The co-types of *bruneri* in the National Museum collection consist of alate forms and apterous females. The principal differences noted between these types and the average specimens of *populicola* are, apart from the size, the antennæ and the body hairs. Segment IV of the alate form has no sensoria or one, whereas in the same segment of *populicola* there are usually several. In many cases, however, this segment in specimens of *populicola* shows only one sensorium. The apterous specimens of *bruneri* on the Connecticut slide, as well as one specimen on the type slide, show hairs which are stout and notched at the tip. This character is also shown in a collection taken for *populicola* in Minnesota. All the other material of *populicola* which the writer has examined shows long normal hairs. This character of the hairs showing in such few specimens may possibly be a specific indication but the writer retains *bruneri* not on the strength of these hairs, but on account of a lack of material suitable for dissection and study in order to fix its status. The following measurements have been made from the cotypes in the National Museum collection.

ALATE VIVIPAROUS FEMALE: Antennæ as follows: Segment III, 0.416 mm. with 17 sensoria; IV, 0.224 mm.; V, 0.208 mm.; VI (0.128+0.16 mm.), Cornicles 0.112.

APTEROUS VIVIPAROUS FEMALE: Antennal segment III, 0.368 mm.; IV, 0.208 mm.; V, 0.208 mm.; VI (0.112 mm. + 0.144 mm.).

KEY TO THE AMERICAN SPECIES OF CHAITOPHORUS
(Alate viviparous females)

1. Wing veins heavily bordered with dark brown 2
   Wing veins not heavily bordered with dark brown 4
2. Antennæ with very few hairs (apterous form with thick spines) . . . *quercicola* (Mon.)
   Antennæ noticeably hairy 3
3. Segment III of antennæ usually with several sensoria (apterous form with straight spine-like hairs) . . . . *populicola* Thos.
   Segment III of antennæ usually with one sensorium (apterous form with notched spine-like hairs) . . . . *bruneri* Wms.
4. Feeding upon species of maples 5
   Feeding upon species of willow and poplar 7
5. Segment III of antennæ with 16 to 24 sensoria somewhat irregularly placed on the basal three quarters of the segment . . . . *americanus* Bkr.
   Segment III of antennæ with 4 to 9 sensoria in a more or less even row 6
6. Unguis of segment VI less than three times as long as the base . . . . *negundinis* Thos.
   Unguis of segment VI much more than three times as along as the base, often more than four times as long . . . . *lyropicta* Kess.
7. Vertex and crown covered with reticulate areas (dorsum of apterous form reticulate) 8

Vertex and crown without reticulations but these replaced by granulations (especially on apterous form) Segment IV with 0 to 2 sensoria.... *viminalis* Mon.

8. Segment IV with 4 to 6 sensoria.................................. *nigræ* Oest.
   Segment IV with no sensoria.................................. *salicicola* Essig

N. B. *Chaitophorus agropyronensis* Gillette is a species of *Sipha*
Chaitophorus flabellus Sanborn is a species of *Saultusaphis*
Chaitophorus betulæ Buckton of Gillette is a species of *Callipternella*
Chaitophorus artemisiæ Gillette seems to be the same form described as *Cryptogsiphum canadensis* by Williams. It is not a Chaitophorus.
Chaitophorus spinosus Oest., is a synonym of *quercicola* Mon.
Chaitophorus cordata Wms., is a synonym of *nigrae* Oest.
Chaitophorus stevensis Sanborn is a synonym of *viminalis* Mon.
Chaitophorus delicata Patch is known only from the apterous forms and is therefore not included in the key
Chaitophorus tridentata Wlsn., the writer has not seen.

Genus Pterocomma Buckton

Pterocomma media n. sp. Taken on poplar, Manchester, Conn., Sept. 3, 1909, by A. I. Bourne Conn. No. 1–16/126 and on Carolina poplar, New Canaan, Conn., Sept. 21, 1909, by A. I. Bourne, Conn. No. 1–16/127.

Alate Viviparous Female: General appearance similar to *beulahensis* Ckll., from which it differs chiefly in the antennæ and cornicles. Antennæ as follows, III, 0.56 mm.; IV, 0.32 mm.; V, 0.272 mm.; VI (0.16 mm.+0.192 mm.). Segment III is covered with a large number of rather small circular sensoria; more distal segments without sensoria. Cornicles 0.256 mm. long, slightly stouter than those of *beulahensis*, being about 0.096 mm. in their greater diameter. They are flanged and somewhat swollen in the middle. Length of forewing 4.28 mm. Hind tarsus 0.24 mm. long, labium extending to the hind pair of coxæ. Length from vertex to tip of cauda about 3 mm. The color characters cannot be obtained from the mounted specimens and no color notes were taken.

Apterous Viviparous Female: Antennal segments as follows: III, 0.544 mm.; IV, 0.256 mm.; V, 0.24 mm.; VI (0.144 mm. + 0.176 mm.). Segments without sensoria. Cornicles 0.256 mm.; hind tarsi 0.24 mm. Labium extending almost to hind pair of coxæ; length from vertex to tip of cauda about 3 mm.

Described from specimens in balsam mounts.
Type in U. S. National Museum. Cat. No. 20346.

Key to the American Species of Pterocomma
(Alate viviparous females)

1. Cornicles without a distal flange and abruptly constricted at the distal extremity.. *flocculosa* (Weed)
   Cornicles with a distal flange and not so abruptly constricted at their distal extremities.. 2
2. Cornicles about twice as long as their greatest diameter........... *smithiæ* (Mon.)
   Cornicles much more than twice as long as their greatest diameter........... 3
3. Cornicles about equal in length to the hind tarsi........................... 4
   Cornicles much longer than the hind tarsi................................ 6
4. Cornicles cylindrical, beak long................................ *populea* (Kalt.)
   Cornicles somewhat swollen, beak short.................................. 5

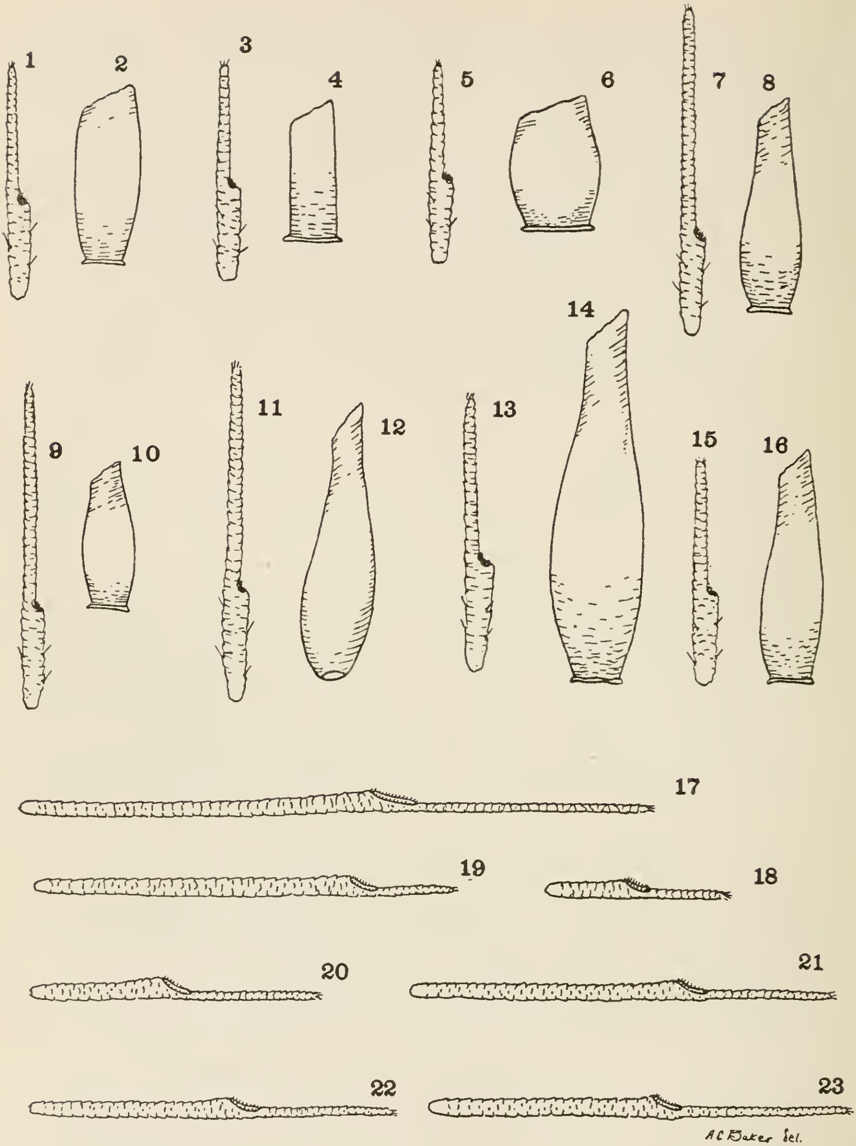


Fig. 21. *Pterocomma media*. 1, distal segment of antenna. 2, cornicle. *P. populea*. 3, distal segment of antenna. 4, cornicle. *P. smithiæ*. 5, distal segment of antenna. 6, cornicle, *P. bicolor*. 7, distal segment of antennæ. 8, cornicle. *P. beulahensis*. 9, distal segment of antenna. 10, cornicle. *P. flocculosa*. 11, distal segment of antenna. 12, cornicle. *P. salicis*. 13, distal segment of antenna. 14, cornicle. *P. populifoliæ*. 15, distal segment of antenna. 16, cornicle. *Euceraphis lineata*. 17, distal segment of antenna. *E. brevis*. 18, distal segment of antenna. *E. deducta*. 19, distal segment of antenna. *E. betulæ*. 20, distal segment of antennæ. *E. mucida*. 21, distal segment of antenna. *E. flava*. 22, distal segment of antenna. *E. gillettii*. 23, distal segment of antennæ. All figures drawn to the same scale.

5. Unguis of segment VI about twice as long as the base.........*beulahensis* (Ckll.)
   Unguis of segment VI one and one-half times as long as base........*media* Baker
6. Cornicles nearly twice as long as the hind tarsi.............................. 7
   Cornicles much more than twice as long as the hind tarsi..................... 8
7. Unguis of segment VI of antennæ about equal in length to the cornicles and about twice as long as base..................................*bicolor* (Oest.)
   Unguis of segment VI of antennae considerably shorter than the cornicles and not twice as long as base.............................*populifoliæ* (Fitch)
8. Cornicles swollen in the middle, bright orange in color............*salicis* (Linn.)

N. B. *Melanoxantherium antennatum* Patch is known only from the oviparous female.

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THE TOMATO AND LAUREL PSYLLIDS

By E. O. Essig, *University of California, Berkeley, Cal.*

Psyllids are also known as jumping plant-lice because of their great similarity in appearance and habits to these insects and their ability to jump freely. The family *Psyllidæ* to which psyllids belong is usually placed next to the family *Aphididæ* (plant-lice), in the suborder *Homoptera* and the order *Hemiptera*. In this order are to be found many of the insects which are very injurious to crops grown in California.

There have been about fifty species described in California so it will be seen that they are not nearly as abundant as either plant-lice or scale insects. None of the native species have become of great economic importance and but one injurious species has been imported into the state.

Two species, at least, the tomato psyllid, a native of the western states, and the laurel psyllid, a native of Europe, are deemed of sufficient importance and interest to warrant a discussion of this kind.

The Tomato Psyllid

Paratrioza cockerelli (Sulc)

(Plate 20, fig. 1 and fig. 22)

This insect has been of some economic importance in Colorado for a number of years and still continues to receive consideration from agriculturists of that state. In California it is widely distributed and though little has been known regarding its economic status, it is coming to be noticed as a garden and field-crop pest in many localities. While it cannot be classed as an insect of major economic importance or even one which may ever cause great losses, it often increases in sufficient numbers to injure the infested plants and becomes a source of loss and worry to the grower.

General Appearance

Eggs (Fig. 22 D).—The eggs are exceedingly small, elongated-oval, with the attached and decidedly pointed end supported by a short petiole and the free end broadly rounded. The color is transparently white or pale greenish-yellow with a more or less definite orange-colored mass at the middle or base. The surface is normally entirely covered with a fine white powdery wax which gives a decidedly gray appearance. The powdery wax is also deposited over the surface of the leaves around the eggs and materially aids in locating them. The average length is about 0.08 mm. They are usually deposited in very great numbers upon the under surfaces of the older well-matured leaves and stand erect or slightly leaning.

Nymphs (Pl. 20, fig. 1, fig. 22 G).—The first born nymphs are very small and transparently pale yellow with orange-colored head and abdomen. The color changes somewhat as the insects mature and when ready for the last molt they are pale greenish-yellow with gray and orange markings on the dorsum. Excepting for the fringe of scale-like spines around the margins (Fig. 22 H) the bodies are perfectly naked. The bodies are very flat, broadly oval and held close to the surface of the leaves when feeding. The excrement is in the form of minute white pellets of honey-dew (Pl. 20, fig. 1) which are

deposited in sufficient numbers to serve as a ready means of locating an infestation. A slight smutting also accompanies the attacks.

Adults (Fig. 22 A). The mature insects are first pale green or light amber but soon become darker, there being a considerable variation in the degree of intensity of the colors. Normally the color is light amber-brown with numerous very dark brown or black markings as shown in the accompanying drawing. A very conspicuous white powdery stripe extends across the dorsal base of the abdomen, and a somewhat definite horse-shoe shaped and quite large area of the same color and covered with fine white powder occurs on the dorsal posterior two thirds of the abdomen. The legs are light amber and sparsely hairy. At the tip of the hind tibiæ there are two apical dark spines on the inside and one on the outside (Fig. 22 C). The antennæ (Fig. 22 I, J) are ten-jointed and dusky, excepting the first three and the basal half of the fourth joints. In many individuals the bases of all the joints excepting the last two are yellow. On the fourth joint near the tip is located a circular sensorium with a peculiar lid or operculum, as shown in Figure 22 B, I, while on each of joints six, eight and nine there is a single simple circular sensorium near the tip. The writer is unable to locate the one on joint two as reported by Sulc. The average length of the body is about 1.8 mm.

Technical Description

The original technical description as given in English by Dr. Karel Sulc is as follows:

Head.—Breadth of the vertex behind the eyes, 0.34 mm., with the eyes 0.52 mm., the length along the middle-line 0.16 mm., posterior margin of the vertex regularly and slightly excised, posterior angles slightly truncate, the anterior ones broadly rounded; a median line divides the vertex in two halves, either showing a distinct fovea in the middle. Antennæ filiform 1 mm. long in all; the length of single joints is: of the 1st, 2nd, 9th, and 10th 0.05 mm., of the 3rd 0.18 mm., 6th 0.13 mm., 7th 0.15 mm., and 8th 0.12 mm.; smell-organs [sensoria] present on the joints 2, 4, 6, 8, 9; that on the 4th joint is very peculiar being in the form of a hollow ball with a circular opening covered with a spoonshaped movable operculum; the other smell-organs show the form of simple pits. The 3 basal joints of the antennæ are yellow, the 4th–8th yellow, brown at their ends, the 2 last black. Frontal lobes very short, 0.06 mm. only long, rounded at the apex. Clypeus in the form of a pearhalf and not produced anteriorly. Colors of the head: the ground yellow-white, in the middle of the vertex a horseshoe-shaped large brown spot, the middle line of the vertex and the frontal lobes dark brown, the apex of the latter being lighter, clypeus yellowish-white.

Thorax: the ground color white-yellowish with a large, well defined brown marking.

Elytræ: length 2.60 mm., greatest breadth 1.00 mm.; apex in the cell. marg. I., nearly at the end of M_{1+2} and forming an acute angle; the anterior part of its margin being a little shorter than the posterior one. C+Sc, R moderately arcuate, R sinuate, ending at the beginning of the second third of M_{1+2}: M slowly arcuate with its apex

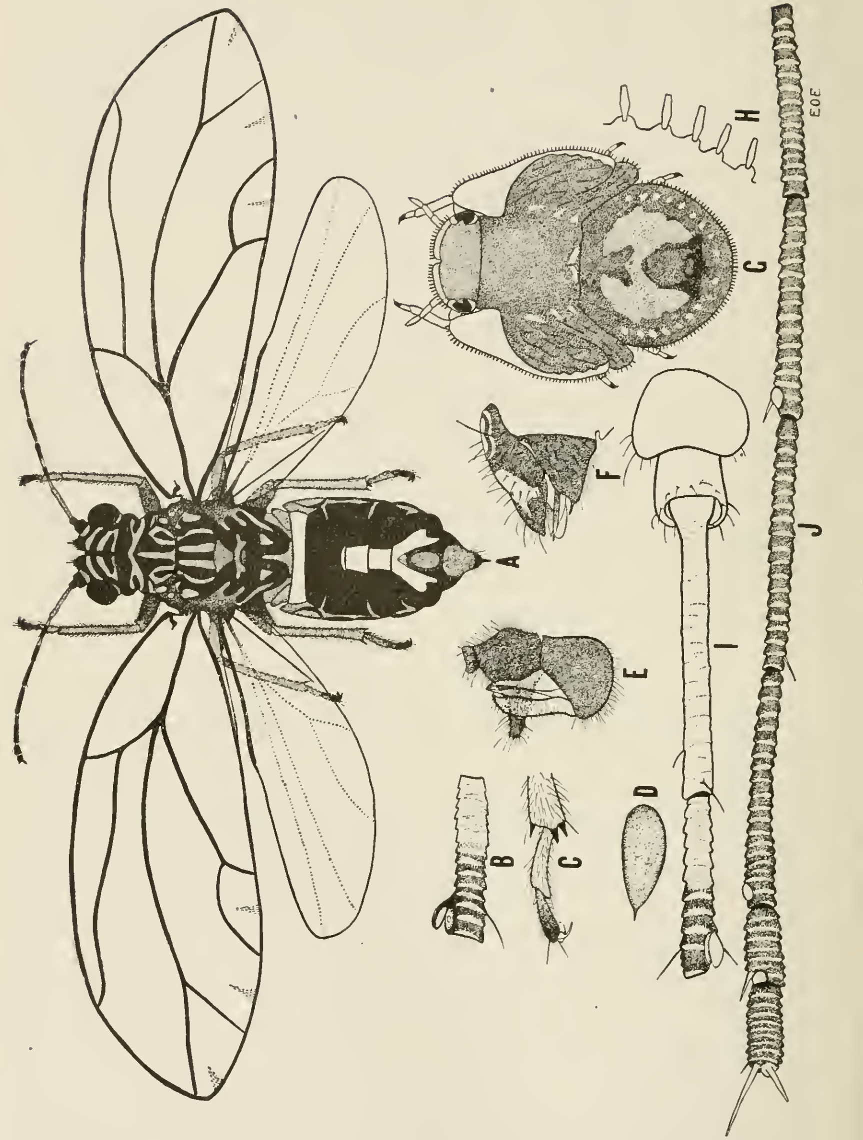

Fig. 22.—The tomato psyllid, *Paratrioza cockerelli* Sulc. *A*, adult female with wings spread; *B*, fourth joint of the antenna showing sensorium with covering or operculum; *C*, tip of the tibia showing apical spines, *D*, egg; *E*, genitalia of the male; *F*, genitalia of the female; *G*, nymph; *H*, fringe of spines around margin of nymph's body (greatly enlarged); *I*, first four joints of the antenna; *J*, last six joints of the antenna. Much enlarged. (Original).

before the middle; M_{1+2} parallel with the wing-axis M_{3+4} almost straight, Cu_1 evenly arcuate. Nervature fine, white yellowish, transversal nervules colorless. Membrane vitreous. No spines on either side of the elytra-membrane; the marginal spines only present and very distinct, forming very narrow, high groups in the cell, Rs, M_{1+2}, Cu.

Hind-wings and legs as usual in the genus.

Apex of the male abdomen: genital segment of equal breadth and height, 0.17 mm.; its posterior and inferior margin evenly arcuate, anterior half of the upper side moderately arcuate; no tubercles; hairs of moderate size, equally scattered on the surface. Color black. Forceps shows the form of a scythe with its edge anteriorly; posterior margin straight, the anterior sinuate; height 0.17 mm., breadth 0.04 mm.; if viewed from behind has the forceps also the form of a scythe, but its edge is turned inwardly and bears at the base a small obtuse tooth; above are the ends of the forceps curved like cattlehorns; hairs equally scattered on the surface. Color brownish. Anal segment 0.17 mm. high, produced posteriorly in a triangular lobe; very long setæ especially on its distal end; color brown.

Apex of the female abdomen. Anal segment viewed from above short, triangular, obliquely truncate at the end; viewed laterally on a preparate boiled in KOH and mounted in glycerin 0.28 mm. long by 0.12 mm. high; its upper margin slightly arcuate rounded at the end; inferior margin straight, slightly excised before the apex; long hairs scattered on the sides, on the upper margin and just under it short, strong, acute spiniform hairs, before the apex a few long, stout and around the anus short little hairs; on the whole surface of the segment very small, short, acute spines in rows parallel with the superior margin.—Anus O-shaped; upper length 0.20 mm., under-length 0.15 mm.; hinder-length 0.24 mm.; apex short acute, its inferior margin straight, the whole surface of the side with long scattered hairs, the hinder half of it with very short, small, acute spines in rows parallel with the posterior margin. External sheath narrowing behind with roundly truncate apex, reaching over the end of the anal segment. The inner stylets straight, obliquely truncate on the underside before the apex; the apex itself acute with two triangular teeth above. The innermost stylets triangular on their end. Color of the anal and genital segments dark brown, sometimes with a few whitish spots.

Length 2–5.3 mm. to the end of closed wings.[1]

Life-History

The winter is passed in the adult stage on evergreen food plants or in sheltered places elsewhere. Eggs are laid late in April and until late fall and early winter in the mild climate of this state. The broods are exceedingly uneven and all stages of the insect may be found from May until the middle or even the last of November. The average length of time required from egg to adult and the number of broods a year are very difficult to fix because of the great amount of variation and uncertainty due to differences in seasons and the difficulty in determining the same. However, there are from three to many overlapping broods each year.

[1] Sulc, Karel, Acta Soc. Ent. Böhemiæ, VI, pt. 4, pp. 105–108, 1909.

Distribution

As previously stated, this insect has a wide distribution in California. It has been taken in great numbers in Alameda County and received from Eldorado County by the writer and has been reported by others from Los Angeles, Inyo (Death Valley and Argus Mountains), Imperial and San Luis Obispo Counties in California and also from the states of Colorado, Utah, Arizona and New Mexico.

Food Plants

The food plants are only imperfectly known and include in California, the following: Alfalfa (Imperial County), tomatoes (San Luis Obispo County), spruce (Los Angeles County), *Pinus monophylla* Torr. (Argus Mountains, Inyo County) as reported by Crawford, and on the following plants on the campus of the University of California, Berkeley Alameda County, by the writer: tobacco, petunia, *Solanum marginatum* Linn., S. *verbascifolium* Banks, *Datura sanguinea* R. &. P., and *Iochroma tubulosa* Benth. It was also received from Placerville, Eldorado County, where it was abundant on potatoes. In Colorado it was first taken on cultivated pepper and later on tomato and common nightshade (*Solanum nigrum* Linn.). In Arizona Crawford lists it on arborvitæ and *Pursia* sp.

Control

Though unprotected and comparatively delicate, this insect is not at all easy to control. At least two factors enter into this: its fondness for the undersides of the older leaves near the ground where it is well protected from sprays, and the delicate nature of the food plants which will not permit the use of a strong spray of any kind. The first factor can only be overcome by very great care in applying the remedy and the second by the use of tested materials. The oil and soap sprays are specially to be avoided as they seem to be particularly destructive to solanaceous plants and are not recommended unless used in very diluted proportions and then only after experimenting on a few plants. Nicotine sulphate or black leaf forty may be used with comparative safety at the rate of from 1 to 1,000 to 1 to 1,500. Prof. C. P. Gillette writes that in Colorado, several remedies have been studied, especially on tomatoes, and only lime-sulphur proved successful. The commercial product was used in the proportions of 1 to 40 and killed the psyllids without serious injury to the plants. A spray of about the same strength has been used experimentally in spraying potatoes for fungous diseases, but proved to be positively harmful to the crop.[1]

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[1] Stewart, F. C. and French, G. T., Bul. No. 347, N. Y. Agrcl. Exp. Sta., pp. 79, 81, March, 1912.

All experiments with lime-sulphur should be first tested on a small scale before extensive applications are made. Fortunately, the insect in question seldom if ever deserves control measures in this state.

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Paratrioza ocellata Crawford, Pomona Jr. Entom. II, No. 2, p. 229, May 1910; also Pomona Jr. Entom. III, No. 1, pp. 447–448, Feb. 1911 (5 figures).

Paratrioza pulchella Crawford, Pomona Jr. Entom. II, No. 2, p. 229, May 1910; also Pomona Jr. Entom. III, No. 1, p. 447, Feb. 1911 (Synonym of *Paratrioza ocellata* Crawf.).

The Laurel Psyllid

Trioza alacris Flor

(Plate 20, figs. 3, 4 and fig. 23)

The laurel psyllid has been the cause of considerable loss to nurserymen in the San Francisco Bay region and has received the attention of local authorities since 1911 when it was first discovered. It was evidently imported from Europe where it has been known as a pest for many years. As an enemy of the laurel it is very pernicious and not only disfigures the foliage, but causes smutting and greatly stunts the plants. Its presence means continued and expensive control measures or very unsightly trees if nothing is done. As the laurel is a favorite ornamental tree and grown generally throughout the state, anything that tends to make it less beautiful should be known and its further dissemination avoided.

Though the known distribution[1] is limited it cannot be long confined to its present areas. Local horticultural authorities are endeavoring to prevent its spread and they are doing much in this direction, but there must be more than local action to make a safe guarantee to the rest of the state. It is sincerely hoped that the few small infestations might be entirely stamped out while this is still possible, before they become too large.

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[1] Since preparing this description the author has received specimens of the adults, nymphs and work of this insect on *Laurus nobilis* from Dr. A. G. Smith of Pasadena, California. This is the first record from the southern part of the state and indicates the possible establishment elsewhere in the state.
Sept. 29, 1916.

General Appearance

Eggs (Fig. 23 D).—The eggs are very pale yellow or transparently-white with a darker yellow or orange-colored area near the tip. The entire surface is covered with a very fine whitish powder which gives a grayish color. The shape is elongate-oval with a pointed base and short stipe which is attached to the leaves and a broadly rounded top. The length averages about 0.07 mm.

Nymphs (Pl. 20, fig. 4 and fig. 23).—The nymphs are pale yellow or partially orange-colored and are covered with a thick white cottony wax which is unevenly arranged and entirely hides the body. The naked bodies are rather slender and only about 2 mm. long while with the covering they appear decidedly wide and from 3 to 4 mm. long. When ready to emerge as adults the nymphs leave the galls, which are made at the edges of the leaves and which afford very good protection, and crawl out on the flat surfaces of the leaves where the old skins are left behind. These cast skins are commonly mistaken for the living forms. The bodies are covered with simple and spear-shaped spines (Fig. 23 C).

Adults (Pl. 20, fig. 4 and fig. 23).—The adults greatly resemble those of the tomato psyllid in general aspects. The bodies are pale amber with darker brownish or nearly black markings, as shown in the accompanying drawing (Fig. 23). On many of the individuals there is a noticeable narrow white line across the dorsal base of the abdomen; while in others this line is entirely absent. The legs and antennæ are pale yellow, with the last two joints of the antennæ black (Fig. 23 A, J). The length of the body averages about 2 mm.

Technical Description

Crawford gives the following technical description of the adults:

Length of body 1.9 mm.; length of forewing 3.2; width of head 0.71. General color greenish yellow to light brown; dorsum in darker individuals more or less striped and streaked with brown; abdomen often brown; antennæ black at tip.

Head nearly as broad as thorax, not strongly deflexed; vertex more than half as long as broad, emarginate in front at median line, with a prominent sulcate impression on each side of median line and parallel to it; genal cones scarcely two thirds as long as vertex, divergent, subacute, not much depressed from plane of vertex. Antennæ about one and a third times width of head, slender.

Thorax not broad, well arched, punctate; pronotum moderately long, not strongly depressed; præscutum rather large. Legs slender; hind tibiæ with two black spines at apex on inside and one outside. Wings long, slender, transparent, fully three times as long as broad, subacute at apex; Rs short.

Genitalia.—Male.—Anal valve a little longer than forceps, hind margin arcuate, with long pubescence; forceps rather stout, sides almost parallel (from side), terminating in a subacute, black point at apex. *Female.*—Genital segment nearly as long as rest of abdomen, acute at apex, valves subequal in length.[1]

[1] Crawford, D. L., Bul. 85, U. S. Nat. Mus., pp. 94–95, 1914.

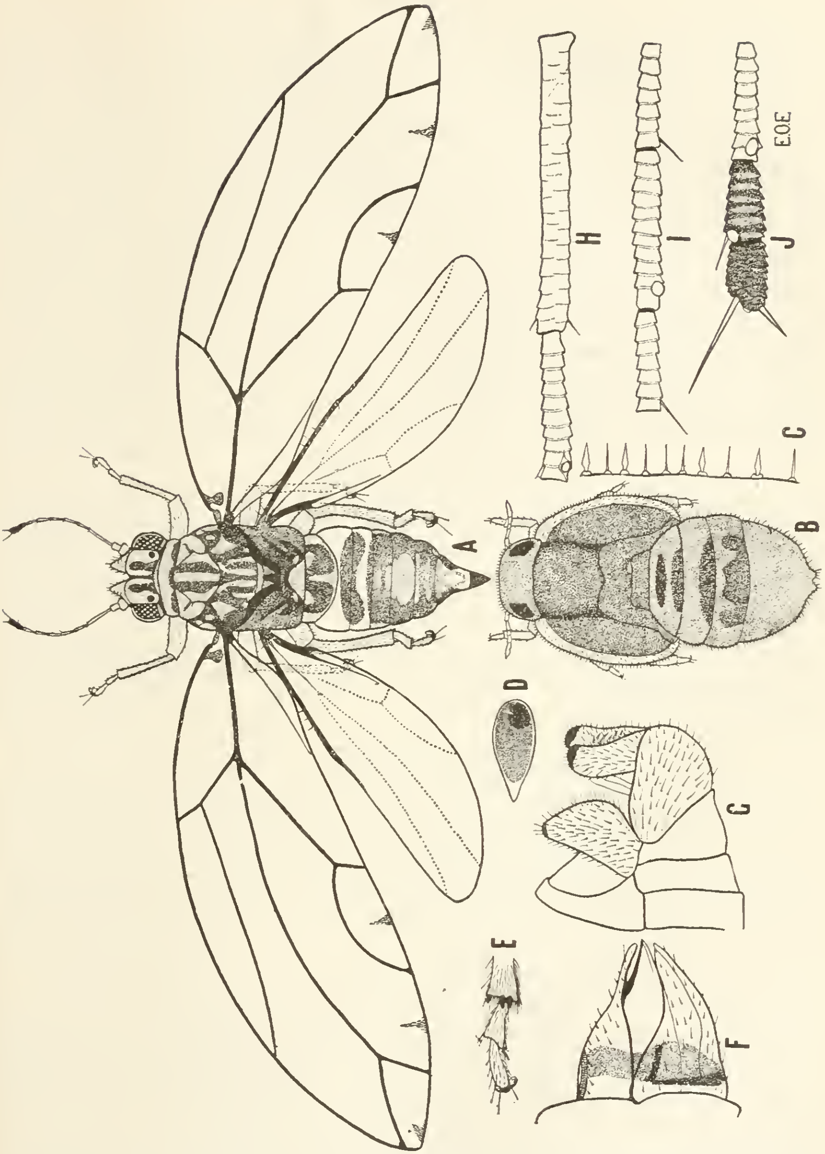

Fig. 23.—The laurel psyllid, *Trioza alacris* Flor. *A*, adult female with wings spread; *B*, nymph with cottony covering removed to show the body; *C*, simple and spear-shaped spines which cover the body of the nymph (greatly enlarged); *D*, egg; *E*, tip of tibia showing apical spines; *F*, genitalia of female; *G*, genitalia of male; *H*, third and fourth joints of the antenna; *I*, fifth, sixth and seventh joints of the antenna; *J*, eighth, ninth and tenth joints of the antenna. All much enlarged. (Original).

Life-History

The winter is passed in the adult stage in a more or less active condition upon the food plants or upon the plants in the near vicinity. In March and April the eggs are laid in few or great numbers on the very small leaves of the tender shoots. The young nymphs feed at the edges of the leaves, causing a decided curling and thickening of those places (Fig. 3) and producing quite a definite leaf-gall. The galls enlarge with the leaves and are at first of the same color, but gradually become lighter and later bright reddish and eventually brown or black. As previously stated, the nymphs usually remain within the galls until maturity is reached when the latter are deserted and often become the abode of other insects, especially mealy bugs (*Pseudococcus* spp.). There are several broods a year, the last one maturing in October and November. Two broods are reported in Europe.[1]

Distribution

The first specimens of this insect were collected in Oakland, Alameda County, and in San Mateo County by Mr. O. E. Bremner.[2] No other infestations were reported until October 1914 when Mr. C. J. Pearsons, a graduate student at the University of California, found it in a nursery at Niles, Alameda County. These are the only known records for California and the United States. In Europe the insect is quite generally distributed.

Food Plants

The only recorded food plant in this state is the laurel or sweet bay (*Laurus nobilis* Linn.). In Europe the insect attacks, besides the above, the cherry laurel or English laurel (*Prunus laurocerasus* Linn.) and the Canary laurel (*Laurus canariensis* W. & B.). As opportunity is afforded these trees will also probably become infested in California.

Control

The control of this pest is very difficult. Besides being covered with a thick waxy secretion which is resistant to sprays, the nymphs are also protected in the leaf-galls from ordinary control measures. The adults which are present practically the entire year are exceedingly active and fly away as soon as the infested plants are disturbed.

Fumigation readily kills all forms, but it is usually impossible to confine the adults under a tent or get them to a fumigating house. The nymphs and eggs, may however, be effectually killed in this way.

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[1] Sulc, Karel, Sitz. Kön. Böh. Ges. Wiss. Prag, pt. XVI, p. 51, 1912.

[2] Crawford, D. L., Mthly. Bul. Cal. Hort. Com., I, No. 3, p. 86, 1912, and Bul. 85, U. S. Nat. Mus., p. 95, 1914.

During the winter months when the adult stage only persists, the plants may be removed to a fumigating house or tent and fumigated and if immediately removed to a safe distance from all other points they may be kept free from reinfestation and shipped elsewhere if they remain clean after a few months' time.

Spraying with miscible oils and oil emulsions readily kills all stages if repeatedly and thoroughly applied. The manufactured grades of miscible oils and kerosene emulsion, crude oil emulsion, and crude carbolic acid emulsion may be used.[1]

Hand-picking has been resorted to in one nursery, but the results have not been satisfactory because of immediate reinfestation.

To get satisfactory results all infested plants must be segregated and removed from other plants to a perfectly clear place and the treatment applied to all as fast as possible and in a definite direction, beginning at one side or end. If the area is so large that it will require more than a few hours to make the treatment, the plants must be removed elsewhere as fast as treated or else they will become reinfested with the adults before the last ones are reached. This has been the fault of most of the work done so far.

Summary

1. Of some fifty described species only two psyllids may be considered of economic importance in California. They are the tomato psyllid, a native species and the laurel psyllid, imported from Europe.
2. The tomato psyllid is generally distributed throughout the state, and, while it prefers solanaceous food plants, also infests others.
3. The tomato psyllid may be controlled by spraying, but is only occasionally serious enough as a pest to warrant a treatment.
4. The laurel psyllid is a serious enemy of the laurel or sweet bay tree, causing disfigurations of the foliage, smutting and generally stunting the plants.
5. The distribution of the laurel psyllid is limited to a few localities in the San Francisco Bay region.
6. When the laurel psyllid is present it is necessary to employ control measures which consist in spraying or fumigation.
7. The laurel psyllid is of sufficient importance to warrant a con-

[1] For the formulæ and methods of preparing and using the above sprays see:

Woodworth, C. W., Circ. No. 128, Cal. Agrcl. Exp. Sta., pp. 3–5, April, 1915 (This circular may be had by applying to the Director of the Agricultural Experiment Station, Berkeley, Cal.).

Essig, E. O., Inj. Ben. Ins. Cal., 2d ed., Cal. Hort. Com., pp. 465–480, May, 1915 (This publication may be secured from the State Commissioner of Horticulture, Sacramento, Cal.).

siderable outlay in money for its eradication which is now possible because of its limited distribution.

(*Berkeley, Cal., Jan. 1, 1916.*)

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Hieronymus,[1] Pax, Herbarium Cecidologicum fasc. VIII, No. 231.
Trioza lauri Targioni-Tozetti, Resocont. Soc. Ent. Ital., p. 19, 1879.

[1] As the dates could not be secured for these references, they are placed at the end.

Explanation of Plate 20

Fig. 1.—The tomato psyllid, *Paratrioza cockerelli* Sulc. Nymphs and their white pellet-like excrement on the underside of a tobacco leaf. Enlarged two and one half times. (Original. !Photo by Dept. of Scientific Illustration, Cal. Agrcl. Exp. Sta.).

Fig. 3.—The laurel psyllid, *Trioza alacris* Flor. Leaf-galls on young shoot of laurel tree caused by the nymphs. The white cottony masses are the old skins of the nymphs. Natural size. (Author's illustration, Inj. Ben. Ins. Cal. 2nd. ed., 1914).

Fig. 4.—The laurel psyllid, *Trioza alarcris* Flor. Adults, nymphs and the cast skins of the latter on a leaf of the laurel tree. Enlarged 6 times. (Author's illustration, Inj. Ben. Ins. Cal. 2nd. ed., 1914).

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Tomato Psyllid

Scientific Notes

The Pink cornworm (*Batrachedra rileyi* Wals.) has been discovered in injurious numbers in corn in several localities in Mississippi, and in less numbers in Louisiana and adjacent states.

Wanted: Coccinellid Parasites. A study is being made of *Epomphaloides minutus* How., a chalcidid parasite of Coccinellids, which so far has been reared by the writer only from species of the genus *Coccinella*. If field men will send definite records of the occurence of this parasite, or any other chalcidid parasites of Coccinellids, together with the name of the host, such information will be greatly appreciated. Parasitized material (the chalcidid parasitizes the larvæ and pupæ of the Coccinellids), or reared specimens of the parasites, in case these have not been determined, are also desired. Address: E. J. Newcomer, General Delivery, Portland, Oregon.

Studying the Eggs of Hemiptera. The older entomologists will recall the work undertaken by the late Mr. Otto Heidemann, relating to the study of the eggs of Hemiptera, which resulted in the admirable paper published by him in 1911. Since then practically nothing has been added to the knowledge of this subject. It is now proposed to take up and continue with this important phase of insect life where Mr. Heidemann left off. The attention of field men associated with the Bureau as well as other entomologists is called to this project in hopes that whenever the opportunity occurs they will send in the eggs of Hemiptera for study and description, Any material will be greatly appreciated, and should be addressed to Edmund H. Gibson, Division of Insects, U. S. National Museum, Washington, D. C.

Further Notes on Preservation of Insect Collections. In the December number of the *Monthly Letter* of the Bureau of Entomology appeared an interesting note from Mr. T. S. Wilson concerning the protection of the insect collections. At this station we have adopted Mr. T. S. Wilson's suggestion of melting naphthalene and pouring it into the lids of Schmidt boxes, finding it much more practicable than the use of naphthalene cones which frequently "go adrift" and do much damage to pinned specimens. At this Station we use for storage purposes great numbers of cigar boxes, and we find that the best method of preventing the ingress of any "museum pests" is to brush melted paraffin about corners and edges of boxes used for such purposes. We have successfully stored large quantities of entomological material and find that after fastening down the lid with a tack that the melted paraffin brushed about the corners of the boxes successfully protects the material.

Wm. B. Turner, *Hagerstown (Md.) Field Station.* Feb. 10, 1917.

Clover Leaf Weevil. The Journal of Economic Entomology for August, 1916' contained "Notes on the Distribution of the Clover-leaf Weevil (*Hypera punctata* Fab.) in Kansas" by Mr. James W. McColloch of the Kansas Agricultural Experiment Station. The writer can add that this species also occurs at Wellington, Kansas.

While carrying on an investigation of a certain insect in Wellington, Kansas, on July 30, 1915, the writer killed several toads to see if the insect under investigation constituted part of the toad's food. One of the toads' stomachs contained an adult (*Hypera punctata* Fab.). The beetle was sent to Washington and determined as this species and the toad was determined by the Biological Survey as *Bufo americanus*. These toads were caught in alfalfa field near Wellington, Kansas.

T. S. Wilson,
Scientific Assistant.

A Directory of Workers in Hemiptera. During February a circular letter and data blank was sent to all entomologists in this country known to be particularly interested in Hemiptera, the object being to get together a directory of workers within the order, listing their projects in hand and past publications. To date more than 30 blanks have returned with detailed data. If any field men connected with the Bureau, or otherwise, are at present engaged in any problem—economic, biologic, or systematic—relative to Hemiptera and have not received a blank to fill in, they will be conferring a favor by sending data under the following headings to Edmund H. Gibson, Divison of Insects, U. S. National Museum, (*a*) Name, (*b*) Address, (*c*) Position and institution affiliated with, (*d*) Character of work, (*e*) Problems in hand or expecting to undertake, (*f*) List of publications.

Monthly Letter, Bureau of Entomology, February, 1917.

The Mediterranean Flour Moth (*Ephestia kuehniella* Zell.). This insect has attracted more attention during 1916 than for several years. It has made its appearance in warehouses and mills where it was not formerly found. The list of localities includes mostly small towns and cities. It is interesting that while formerly when this species was so very abundant, nearly all millers knew the insect as the Mediterranean flour moth, at the present time they refer to it as "weevil," "flies," and infested material is seldom accompanied by other species of insects. One correspondent writes, "We are worried with a fly that lays eggs, apparently these hatch, and a worm gets in all elevators and spouts, causing a web which takes a very little time to fill cups and spouts, causing web in the flour, and interfering with the flow of the mill."

Hymenia perspectalis Hubner, a Greenhouse Pest. My good friend, Mr. William Falconer, the superintendent of the Allegheny Cemetery, Pittsburgh, on January 10, 1917, came to me, bringing with him a number of specimens of *Hymenia perspectalis* Hübner, and several potted plants of *Alternanthera* which showed the ravages of the larvæ of this little moth.

He reports to me that the insect has confined its attentions to the young plants of *Alternanthera*, which is extensively propagated in the green-house for use in the borders of parterres. Its work has been almost ruinous, and, as this is the first time he has ever seen the thing, he was naturally anxious to learn more about it. I have not taken the time to make a search of the recent literature of the subject to ascertain whether it has been recorded as a pest in other places, but simply call attention in these lines to the fact that, if allowed to propagate in green-houses and conservatories, it may do great damage to the above-mentioned plants.

W. J. Holland.

Carnegie Museum, Pittsburgh, January 25, 1917.

The Life-histories of the Cattle Lice. The life-histories of these species have been worked out during this winter. Ten specimens of the short-nosed ox louse (*Hæmatopinus eurysternus*) were placed on a restricted region on the shoulder of a Holstein calf that was less then twenty-four hours old. The white eggs were soon laid. These were observed once each day and the eggs hatched in from seven to eight days after they were laid. These young were removed and placed on another calf and these laid eggs in from fifteen to sixteen days after hatching, making a life-cycle of from twenty-two to twenty-four days. The female of this species lays from thirty-five to fifty eggs each. The life-history was checked on other calves.

The life-history of the long-nosed ox louse (*Hæmatopinus vituli* Linn.) was very similar though it was slightly longer. The method used was the same as in the previously mentioned louse. These insects were placed in a white patch where the shining black eggs hatched in from eight to nine days and the lice again laid eggs in from

seventeen to eighteen days after hatching, making a life-cycle of from twenty-five to twenty-seven days.

The little red biting lice (*Trichodectes scalaris* Nitz) have been much harder to determine owing to the difficulty in keeping them confined. From the writer's observations supplemented by the hatching of eggs in an electric incubator it is believed that they hatch from the eggs in from five to six days and mature in two weeks though more work must be done on this species to determine its life-cycle with the accuracy of the two previously mentioned species. This would indicate that a treatment might be repeated with the best results from ten days to two weeks after the first treatment.

The experimental work on the control measures will appear in the future in a bulletin from the Storrs Experiment Station.

G. H. Lamson, Jr.,
Storrs, Conn.

An Infestation of Lasius niger L. var. americana with Laboulbenia formicarum Thaxter. On April 7 the writer collected a number of ants of the species *Lasius niger* L. var. *americana*. Upon close examination under a binocular microscope fungus growths were observed on the ants. The fungus occurred particularly on the posterior part of the head, the dorsal surface of the abdomen, and the femora and tibiæ. Every worker examined from one colony was affected, some having more hyphal outgrowths than others. The fungus was identified by Professor R. F. Griggs of Ohio State University as *Laboulbenia formicarum* Thaxter. The fungus apparently had no injurious effects upon the ants, which were as lively as those not parasitized, and the organism is of interest because of its rareness rather than through its effect upon the host. The writer examined the ants of several adjoining colonies but found the individuals of only one other colony infested. This colony was about fifteen feet from the original colony and may have been connected with the former by means of subterranean galleries. Dr. Thaxter of Harvard University has made an interesting study of this and other Laboulbenia, all of which affect insects exclusively.

M. R. Smith,
Department of Entomology and Zoölogy, Ohio State University.

Credit to Whom Credit is Due. On a recent visit to the Bureau of Entomology, through the courtesy of Dr. L. O. Howard the following facts were ascertained:

The anonymous person mentioned by C. V. Riley in his article on the Ox Bot of the United States 1892, was Mr. F. G. Schaupp of Shovel Mount, Texas, a special field agent of the U. S. Department of Agriculture. Dr. Howard kindly showed me a number of letters from Mr. Schaupp dated March, 1892, proving conclusively that he was the experimentor and that Riley merely recorded his observations. The anonymity of that time was on account of personal matters relating to Mr. Schaupp. The principal reason for my writing this note is on account of a somewhat severe criticism I made of the late Professor Riley in Parasitology, 1915, saying that his records were not his own, and also to give credit to Mr. Schaupp for his excellent and valuable experiments on the life-history of *H. lineatum*. Seeing that Professor Riley is dead and that Mr. Schaupp was buried at San Antonio on November 10, 1903, there seems to be no further necessity for keeping his name secret. Mr. Schaupp was the first president of the Brooklyn Entomological Society and is well known for his work in Entomology, especially on the Coleoptera. In conclusion it might be mentioned that Mr. Schaupp was the first discoverer of the eggs of *H. lineatum* and that he also made some valuable notes on the method of oviposition; therefore I think that in future his name should be mentioned in all articles relating to past experiments on Warble-flies.

Seymour Hadwen,
Agassiz, B. C.

Megastigmus aculeatus Swed., Introduced into New Jersey from Japan. (Hymen.) At different times during the past few years, rose growers have complained somewhat, of the failure of Japanese *Rosa multiflora* seeds to germinate. Upon collecting samples of the seeds and keeping them under observation, it was found that they were heavily infested by a member of the *Torymidæ*, which was later identified by Mr. Girault through the courtesy of Dr. L. O. Howard as *Megastigmus aculeatus* Swed. The larvæ of this genus are known to live in the seeds of plants and C. R. Crosby in "A Revision of the North American Species of Megastigmus" (An. Ent. Soc. Amer., vol. 6, No. 2, pp. 155–170, June, 1913) states that this species was reared from rose seeds at Ithaca, N. Y., and that in the collection of the U. S. National Museum, there is a series of specimens reared from rose seeds imported from Peking, China. He also reared specimens from rose hips received from Germany. In order to determine definitely if the species was being imported into New Jersey from Japan, samples of *Rosa multiflora* seeds were taken from nearly every shipment consigned to the State during the spring of 1917. After keeping them nearly fifty days, parasites emerged from all of them about the latter part of May. The larva appears to destroy the entire interior of the seed leaving nothing but the hard outer covering.

HARRY B. WEISS,
New Brunswick, N. J.

Migration of Danaus archippus. Miss Joanna Carey writes from La Junta, Colorado, that on April 26 a "cloud of butterflies" arrived at that place, at about 5.30 in the evening. They seemed to be carried before a very hard wind which was blowing from the east or northeast. Great numbers were to be seen later on the grass, trees and sidewalks. Two specimens sent are both males.

T. D. A. COCKERELL.

A Correction. Line 25, page 260, vol. 10, No. 2, Journal of Economic Entomology, should read "larvæ of the three probable parasites" instead of "larvae of the three parasites probably."

WM. P. HAYES.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1917

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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Applied or practical entomology is so obviously that phase of entomology which is useful or of immediate value that further definition appears unnecessary. Numerous efforts being made to conserve and increase the food supply and natural resources of the nation lead us to question seriously whether our entomology is sufficiently practical to measure up to the present needs of the day. There have been during the last few months various efforts to bring the practical applications of entomology more closely home to the fruit grower and the farmer. The letter, the circular, and the printed sheet have been used freely, and yet it is probable that some of the most effective work has been accomplished through county or other local agents with more or less of an official standing. The county agent has served as both the eye and the interpreter for the entomologist, reporting upon developments in the field, and personally explaining and supervising preventive and control measures. The right man in the field can undoubtedly accomplish much in bringing about a better handling of the insect problem, since most farmers are much more favorably inclined toward a tactful discussion and demonstration than a more or less lengthy letter or bulletin giving directions for procedure.

The value of this work must depend in large measure upon the possibility of anticipating insect injury. The first year under such a system cannot begin to be as successful as later ones because it is very difficult, in fact almost impossible, to anticipate local developments without some previous experience. Moreover, the significant features,

entomologically speaking, of one season differ from those of another, and it is only through careful study extending over a series of years that the scientist and the field worker can coöperate in a highly efficient method of reporting and disseminating information, involving, as this does, discrimination between the vital and the comparatively unimportant, and the forecasting of developments. The present season has demonstrated more fully, perhaps, than any other during the last twenty-five years the profound influence which seasonal conditions may have upon certain insects. These modifications can be forecast in only a general way and are bound to be changed within comparatively narrow limits by local variations.

Current Notes

Conducted by the Associate Editor

Mr. Frederick Knab has been elected a fellow of the Entomological Society of America.

Miss Ina L. Hawes, S. B. Simmons College, 1917, has been appointed assistant in the library of the Bureau of Entomology.

Mr. E. C. Cotton, Elyria, Ohio, has been appointed Chief of the Bureau of Horticulture of the Ohio Department of Agriculture.

On June 5, Dr. A. L. Quaintance and Mr. E. H. Siegler of the Bureau of Entomology visited the Connecticut Agricultural Experiment Station, New Haven, Conn.

The Bureau of Entomology has received word that the Zoölogical Record, Regent's Park, London, N. W., England, has temporarily suspended publication, owing to the war.

Mr. Arthur Gibson, Assistant Dominion Entomologist of Canada, and Mr. E. M. Schalck, Assistant to the State Entomologist of Illinois, recently visited the West Lafayette, Ind., Field Station of the Bureau of Entomology.

Mr. B. A. Porter, a graduate of the Massachusetts Agricultural College, has been appointed to assist R. A. Cushman in the study of hymenopterous parasites of deciduous fruit insects and will be stationed at Wallingford, Conn.

The last legislature of Connecticut increased the appropriation for general work against insect pests from $8,000 to $12,000, and for gipsy and brown-tail moth suppression work from $21,000 to $40,000 for the next biennium.

According to *Science*, Professor D. L. Crawford of Pomona College, Claremont, Calif., has been appointed Professor of Entomology in the College of Hawaii, Honolulu, H. I., for a period of three years, beginning in September 1917.

On June 6, Dr. L. O. Howard, Washington, D. C., Dr. T. J. Headlee, New Brunswick, N. J., and Dr. W. E. Britton, New Haven, Conn., attended a meeting of the National Malaria Committee at the Hotel Biltmore in New York City.

A new division has recently been created in the Bureau of Animal Industry of U. S. Department of Agriculture, to be known as The Tick Eradication Division, and devoted exclusively to the work of eradicating the cattle fever tick in the South.

Dr. E. A. Back, of the Bureau of Entomology, has been placed in charge of the new section of Stored-Product Insect Investigations, recently organized in the Bureau. He spent June 15–16 visiting the Department of Entomology of the Kansas Experiment Station.

Mr. Louis A. Stearns, graduate of Ohio Wesleyan University and Ohio State University, has been appointed for temporary work on insects as carriers of disease in coöperation with the H. J. Heinz Company and the Bureau of Plant Industry at Madison, Wis.

The section on Deciduous Fruit Insect Investigations of the Bureau of Entomology has recently established a field station in Wallingford, Conn., and will take up the study of the tent caterpillar, the apple maggot, and certain other fruit insects. Mr. E. H. Siegler is in charge.

The following transfers have been made recently in the Bureau of Entomology: G. A. Runner from Southern Field Crop Investigations to Deciduous Fruit Insect Investigations, with headquarters at Sandusky, Ohio; A. B. Champlain, Lyme, Conn. to Falls Church, Va.; E. H. Siegler, Washington, D. C., to Wallingford, Conn.

J. D. Mitchell of the Bureau of Entomology has begun an investigation of two rice insects which have caused very large losses in Matagorda County, Tex. Both species are new as enemies of rice. Together they have destroyed the greater part of forty thousand acres of rice, and threaten to spread extensively during the coming season.

On June 6, W. Dwight Pierce received the degree of Doctor of Philosophy from the George Washington University, Washington, D. C. The title of his thesis was "Comparative Morphology of the Insect Order Strepsiptera." The minors were "The Relation of Insects to Disease," and "The Relation of Climate to Insect Life and Activity."

Dr. A. G. Boving and F. C. Craighead, of the Bureau of Entomology, are very anxious to secure living adults of *Corydalis* for anatomical purposes. It will be appreciated if any one who finds adults of the "Dobson fly" will send them alive (in small tin can) to either Dr. Boving at U. S. National Museum or Mr. Craighead at East Falls Church, Va.

A series of meetings of beekeepers were held early in July at points in Vermont under the supervision of Dr. Burton N. Gates, now a Collaborator of the Bureau of Entomology. A similar series of meetings is being arranged in western Maryland which will be attended by Kenneth Hawkins and G. H. Cale of the Maryland State College of Agriculture, now Collaborator of the Bureau.

According to *Science*, Messrs. George P. Englehardt, Curator of Invertebrates, and Jacob Doll, Curator of Lepidoptera in the Brooklyn Museum, have, through the generosity of Mr. B. Preston Clark of Boston, undertaken an expedition to the plateau regions of southwestern Utah and Northern Arizona, and will give particular attention to lepidoptera, small mammals and reptiles.

One of the salient features of the initial number of the Emergency Entomological Service issued May 1, is covered under the title "Bioclimatic Law as Applied to the Hessian Fly," by A. D. Hopkins, Forest Entomologist, and is the first direct effort in the application of phenological data to insect emergence and crop planting. (Inquiries and suggestions should be addressed to Dr. A. D. Hopkins, Forest Entomologist, Bureau of Entomology.)

Subscriptions are being received from the employees of the U. S. Department of Agriculture for a fund of $1,450 to be used in donating a fully equipped Red Cross ambulance for use in Europe. This gives a very definite means for aiding in the important work of the Red Cross. The ambulance will be known officially as the United States Department of Agriculture Ambulance. Subscriptions should be sent to Mrs. H. S. Bishop of the Bureau of Entomology.

The following have recently been appointed to the Bureau of Entomology: E. L. Sechrist, Fairoaks, Calif., Assistant in Apiculture, Drummond, Va.; G. N. Wolcott, special field assistant, sugar cane insects, Louisiana and Texas; Torbert Stack, Tallulah, La., K. B. McKinney, A. D. Bosley and F. G. Sorrells, Clarksville, Tenn., temporary field assistants; H. J. Hart, Falls City, Neb.; Dr. Burton N. Gates, Amherst, Mass., and G. A. Gale, College Park, Md., Collaborators; Miss M. A. MacNab, Clerk, Falls Church, Va.

Prof. A. C. Burrill resigned last summer from the position of Assistant Entomologist of the Wisconsin Experiment Station and Instructor in Economic Entomology in the Agricultural College to become Entomologist of the Idaho Experiment Station and Assistant Professor in the Zoölogy and Entomology Department of the University of Idaho. This summer Professor Burrill is in charge of the new substation for entomological work, especially clover aphis, at Twin Falls, Idaho, the heart of the irrigated empire of the Snake River plains.

The following were visitors to the Bureau of Entomology during May: Dr. Burton N. Gates, Massachusetts Agricultural College, Amherst, Mass.; A. F. Burgess, In Charge of Moth Work, Melrose Highlands, Mass.; W. M. Mann, of Bussey Institution, Forest Hills, Mass.; Fred Muir, Assistant Entomologist of the Hawaiian Sugar Planters' Experiment Station, Honolulu, Hawaii; D. M. Rogers, Gipsy Moth Investigations, Boston, Mass.; W. F. Fiske, late of the Bureau of Entomology, who has recently returned from the British service in Africa.

Charles Fuller Baker, A. M., Professor of Agronomy, College of Agriculture, University of the Philippines (stationed at Los Banos, Philippine Islands), announces that he is taking a year's leave of absence, and that for this year he has accepted, under temporary appointment, the post of Assistant Director of the Botanical Gardens at Singapore, in charge of experimental work in Tropical Agronomy. After May 12, 1917, and until further notice, all correspondence should be addressed to him, care of Botanical Gardens, Singapore, Straits Settlements.

August Busck, of the Bureau of Entomology, has returned from his trip to Mexico where he made a careful examination of cotton fields on both sides of the Mexican border in the Brownsville-Matamoros region without finding any evidence of the pink bollworm. Neither was any evidence of infestation found in the district opposite Eagle Pass, Tex., but two Mexican plantations near the United States were found on which considerable areas of cotton had been planted with seeds imported from the Laguna district. There is every reason to anticipate, therefore, that in these fields the pink bollworm will develop this year. A very strict watch must be maintained, and whatever remedial steps are possible will be undertaken in coöperation with the Mexican authorities.

Mailed August 20, 1917.

EXCHANGES.

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N. Y. State College of Agriculture, Ithaca, N. Y.

WANTED—List of Col. of Amer. Henshaw, 1885; Col. of So. Cal. Fall; Insects of N. J. Smith, 1909; Bib. Econ. Ent. Part IV.

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HUGH GLASGOW, Agricultural Experiment Station, Geneva, New York.

WANTED—Vol. 1, No. 2, Insect Life; also Canadian Entomologist, November 1899. J. G. SANDERS, P. O. Box 756, Harrisburg, Pa.

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CURRENT NOTES AND NEWS should be sent to the Associate Editor, W. E. Britton, Agricultural Experiment Station, New Haven, Conn.

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CONTENTS

JOURNAL
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VOL. 10 OCTOBER, 1917 No. 5

MISCIBLE OIL VERSUS FISH OIL SOAP SPRAYS FOR THE CONTROL OF FLORIDA ALEYRODIDS[1]

By E. A. BACK and S. S. CROSSMAN, *Bureau of Entomology*

Since the Division of Tropical and Subtropical Insect Investigations began its study of the Aleyrodid pests of *Citrus* in Florida in 1906, spraying experiments have been carried on more or less continuously, although for the first three years they were made secondary to problems associated with the biology of the pests (1) and their control by natural agencies (2) and fumigation (3, 4). Yet, in spite of the disconnected character of the work, a relatively large amount of data were secured either by, or under the direction of, Dr. A. W. Morrill, who was, until August, 1909, in field charge at Orlando. The work during this period definitely determined the relative value of the various home-made and the proprietary spray materials then on the market and gave data which proved beyond question the superiority of certain miscible oil sprays and standard brands of fish oil soap (5). The miscible oils tested, however, were rather expensive and, being of a proprietary nature, could not be recommended unreservedly. The development, therefore, during the past few years, by Mr. W. W. Yothers of the Bureau, of home-made miscible oil sprays, that are cheap, dependable and easily made, has been of great practical value to the citrus industry, and the enthusiasm with which his various formulæ and his spraying schedule for the control of Aleyrodid, rust mite and scale insect pests have been accepted by the leading citrus growers of Florida is evidenced by the rising vote of thanks given Mr. Yothers by the members of the Florida Horticultural Society at their 1915 meeting held at Tampa.

[1] Published with the permission of the Secretary of Agriculture.

Data proving the effectiveness of these home-made miscible oils have already been published by Messrs. Yothers and Crossman (6 to 9) and have been corroborated, if corroboration were necessary, by the senior writer during February and March, 1912, when he had temporarily resumed field charge of the investigations, and was assisted by Messrs. Wooldridge, Strickland and Rutherford. The data secured at this time merely emphasized the dependableness of Mr. Yother's formulæ, and various modifications of them. Sprays containing from $\frac{1}{4}$ per cent to 3 per cent oil were used without injury to foliage. It was rather surprising to find that sprays containing $\frac{1}{2}$ per cent and $\frac{1}{4}$ per cent of oil, made according to Formula IV of Mr. Yothers (7) were very effective, and it seemed probable that strengths less than the 1 per cent of oil recommended might be used profitably, particularly during the summer. Thus on 55 leaves picked from trees sprayed on February 27 with $\frac{1}{4}$ per cent oil and known to have been hit by the spray, 98.4 per cent of 5,040 pupæ were killed; while from two collections of leaves picked promiscuously from the trees which were sprayed at the same time and with the same strength of oil, 98.1 per cent of 1,972 pupæ found on 41 leaves and 98.7 per cent of 6,897 pupæ on 100 leaves were killed.

The purpose of this article is not so much to call attention to the effectiveness of home-made miscible oil sprays recommended by the Bureau, as it is to present certain data secured by the writers during the summer of 1910 which form a basis for comparison between these sprays and those made of fish oil soap. The results are based upon work with a proprietary miscible oil then on the market and a good fish oil soap. An analysis of the miscible oil made by the federal Bureau of Chemistry at the request of Mr. C. L. Marlatt, in charge of the Florida investigations, proved it to be practically the same as the home-made emulsions recommended later by Mr. Yothers. The analysis is as follows: specific gravity at 20° C., 0.9123; unsaponifiable oils (mineral oils), 63.24 per cent; fatty acids (from soap), 5.61 per cent; sodium oxid (Na_2O), 0.63 per cent; water and undetermined, 30.52 per cent; rosin oil not present.

So far as the writers are aware, no data have been published on the effect of summer showers upon the efficiency of insecticides in Florida. During the summer of 1910 a large amount of such data were secured which, in a greatly abridged form, is presented in Table I.

The complete data are on file. Each percentage recorded in Table I is an average of from three to seventeen similar averages, each in turn based upon an examination of over a thousand larvæ and pupæ. At least 210,000 larvæ and pupæ were examined.

The data indicate that the miscible oil sprays are scarcely affected

Table I.—Effect of Summer Showers upon the Effectiveness of Miscible Oil and Soap Sprays

Miscible Oil, Strength	Period of Time between Application of Spray and First Showers	Percentage of Larvæ and Pupæ Killed	Fish Oil Soap Strength	Period of Time between Application of Spray and First Showers	Percentage of Larvæ and Pupæ Killed
$1\frac{3}{4}$%	35 min. to 30 hours	98.2	16 lbs. to 50 gals. water	35 min. to 5 hours	90.2
	5 to 30 hours	98.6		5 to 10 hours	92.6
	30 to 34 hours	98.8		24 to 30 hours	96.2
	99 hours	99.3		99 hours	97.4
$1\frac{2}{3}$%	1 min. to 5 hours	95.3	14 lbs. to 50 gals. water	1 min. to 5 hours	81.7
	5 to 34 hours	96.9		5 to 10 hours	82.5
	99 hours	99.5		27 to 32 hours	85.2
				99 hours	97.0
$\frac{3}{4}$%	35 min. to 5 hours	92.0	12 lbs. to 50 gals. water	35 min. to 5 hours	72.8
	5 to 10 hours	92.5		5 to 10 hours	73.7
	24 to 34 hours	93.2		27 to 32 hours	74.4
				99 hours	97.6
			8 lbs. to 50 gals. water	1 min. to 2 hours	68.6
				99 hours	96.2
			5 lbs. to 50 gals. water	2 hours	71.8
				99 hours	79.8[1]
				No rain (spring)	96.3[2]

[1] Larvæ in third and pupal stages, and therefore more resistant to this strength.
[2] Larvæ in first and second stages.

by showers, except when these fall almost immediately after application. Detailed data show that summer showers falling after the oil spray has once had an opportunity to dry on the foliage, have very little effect upon the efficiency of the spray. Since the leaves gathered for the examination of the Aleyrodids were picked promiscuously, one must be prepared for slight unexpected variations in the percentages of forms killed. The main point to be emphasized is the greater weakening effect showers have upon the different strengths of soap spray than upon those of the oil spray. Thus showers, falling about 30 minutes after the oil spray had been applied, had little effect upon the percentage of forms killed, while they had a very evident effect upon that killed by the soap spray. The weaker strengths of fish oil soap were much more influenced by showers than the weaker strengths of the oil spray.

Miscible oil sprays appear to have a second advantage over soap sprays in that aside from being more resistant to showers, they are operative over a longer period of time after application, even when

no showers fall. Foliage sprayed with miscible oils remained slightly oily both in appearance and to the touch for several weeks after the sprays had been applied. Fish oil soap leaves no such evidence that the trees had been sprayed. In experimental work on a large scale, it became quite evident that the miscible oil sprays used were giving better results than the soap sprays. An examination into the subject proved that the greater efficiency of the oil spray seemed not to be due to a higher percentage killed of the larvæ and pupæ on the leaves when the spray was applied at the proper strength, but to the effect these insecticides had upon unhatched eggs or the young larvæ hatching therefrom within ten days to two weeks after application. The data in Table II represent the condition of the white flies in adjoining rows of the same badly infested grove during the summer of 1910.

Table II.—Reinfestation of Foliage Following Use of Miscible Oil and Soap Sprays

Insecticide	Percentage of Larvæ and Pupæ Killed	Total Number of Larvae and Pupæ Counted	Total number of Leaves Examined	Total Number of Leaves Counted to Determine Reinfestation	Average Number per Leaf of 1st and 2nd Instar Larvæ Hatching after Spraying
Miscible oil $1\frac{3}{4}$%	98.3	20389	170	170	0.9
Miscible oil $1\frac{2}{3}$%	98.0	72270	995	995	1.4
Miscible oil 1%	95.7	28077	500	165	2.0
Miscible oil $\frac{3}{4}$%	92.5	21344	170	170	2.1
Fish oil soap:					
16 lbs. to 50 gals. water	92.8	27712	225	225	8.2
14 lbs. to 50 gals. water	84.5	74642	705	398	12.7
12 lbs. to 50 gals. water	74.5	36103	350	211	10.9
8 lbs. to 50 gals. water	71.7	8247	400	125	24.2

The examinations upon which the data of Table II are based, were made between two and three weeks after the application of the spray. At all times during the summer months adults of both *Dialeurodes citri* and *D. citrifolii* are more or less abundant and depositing eggs. At times of summer spraying there are comparatively few leaves on infested trees, especially those infested by *citri*, that do not bear unhatched eggs in varying numbers. Those in touch with the white fly problems appreciate the fact that no matter how effective an insecticide may be in killing larvæ and pupæ on the leaves at the time the spray is applied, if it does not either kill these unhatched eggs or is operative long enough to kill larvæ that subsequently hatch, much of the benefit of the spraying is counterbalanced by the reinfestation thus brought about. In one grove in which 95 per cent of the larvæ and pupæ were killed by fish oil soap, a sufficiently large number of larvæ hatched after the spray was applied to cause a blackening of the

foliage within a comparatively short time. In a second grove sprayed with the miscible oil mentioned above, an equally large number of insects were killed, but the grove remained clean, *i. e.*, free from sooty mold on the leaves and fruit, for a very much longer time. Two neighboring groves sprayed during late April when the Aleyrodids (*citri* and *citrifolii*) were mostly in the early larval stages, one with the miscible oil used at the strength of $1\frac{3}{4}$ per cent oil, and the other with fish oil soap, 5 and 8 pounds to 50 gallons of water, perhaps emphasizes the importance of the point in question more than any large scale work undertaken by the writers. Both groves were sprayed by the writers and Mr. W. W. Yothers with equal thoroughness and with the aid of a power outfit. Results secured about ten days after spraying showed that the fish oil soap at 5 pounds to 50 gallons had killed as many insects as the miscible oil, and it was regretted that fish oil soap had not been used on both groves on account of the saving in the cost of insecticide. However, the grove sprayed with fish oil soap began to blacken and by July required a second spraying and needed a third by October to keep the fruit free from sooty mould. On the other hand, the grove sprayed with the miscible oil remained clean throughout the summer and was blackening in October only in places.

It is unfortunate that the percentage of larvæ and pupæ killed by the oil and soap sprays, given in Table II, are not more alike as there may be those who will think the much larger average number per leaf of living first and second instar larvæ, found on the leaves two to three weeks after spraying, is the direct result of the comparatively small number of forms killed by the fish oil soap at the time of application. It is possible, and more than probable, that in any grove so heavily infested, even if practically all the forms had been killed by the sprays at time of application, a certain amount of reinfestation from without would occur as migrating adults are quite active and may begin ovipositing within a day after emergence. However, the rows of trees sprayed with both oil and soap sprays were equally subject to reinfestation. No examinations for the first and second instar living larvæ were made until two to three weeks after the spraying in order to give the insects in these instars when the spray was applied, and that escaped the action of the spray, an opportunity to develop into third instar larvæ. Studies of the biology of *citri* (1) have proved that during the summer months the egg stage averages 10–12 days; the first larval, 7.2 days; and the second larval, 5.4 days. The corresponding instars of *citrifolii* are a trifle longer. These facts make it certain that the first and second instar larvæ recorded as living are those which hatched from the eggs present on the foliage when it was sprayed, or from a relatively small number of eggs deposited after spraying.

It cannot be stated whether the oil spray killed a larger percentage of the eggs than the soap spray as the eggs themselves were not examined at the time of spraying, and the newly hatched larvæ which would naturally feel most the hold-over effect of the spray are quite apt to fall from the leaf if they succumb before they have settled to feed. As the spraying was done by the writers themselves with the aid of a power outfit, on the same days and after much experience in manipulating a spraying outfit, it is unlikely that the oil and soap sprays were applied with such differences of thoroughness as to account for the marked differences in effectiveness recorded in Table II. As each strength of insecticide used in the work of Table II is known to be effective from a killing standpoint if brought in contact with each insect and permitted to act unmolested by rains, with the exception of the weakest strength of fish oil soap when used against mature larvæ and pupæ, the writers are of the opinion that the differences in the general effectiveness of the oil and soap sprays used were due partly to the weakening effect of showers, and, in the case of the miscible oil, to the hold-over effect of the insecticide upon the eggs or the larvæ hatching from eggs during at least a ten-day period after spraying.

Incomplete as are the data presented in this paper, they indicate an advantage that miscible oil sprays have over fish oil soap sprays which is of a most practical, though subtle, nature. When growers of *Citrus* appreciate that it is much more profitable, and not more expensive, to spray their groves when the average number of Aleyrodids per leaf is small, rather than large, as is now the custom, this advantage will be even more valuable in postponing future blackening of the trees and fruit by the sooty mould.

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HOW TO TEST FOR THE PRESENCE OF NICOTINE ON SPRAYED PLANTS

By V. I. Safro, *Louisville, Ky.*

It has been generally believed that as soon as a nicotine spray dries on the plant it disappears and that any results following the application of nicotine must necessarily occur immediately or very shortly after the application. This belief, however, has been rendered uncertain in the light of recent developments, several of which have appeared in print, regarding the effects of nicotine insecticides.

The writer conducted some tests last fall which showed definitely that nicotine may be present a considerable time after the spray has dried and apparently disappeared from the plant. This new finding tends to assist in explaining some of the hitherto unlooked for effects of the application of nicotine insecticides. Because of the wide-spread interest among entomologists and the many inquiries the writer has received as to the method of indicating the presence of nicotine upon sprayed plants, he believes it will be of interest to describe briefly the procedure, so that entomologists may be in position to conduct tests of this kind in the course of their own investigations.

The Test

Take a number of leaves that have been sprayed and which it is desired to test for nicotine, and thoroughly rinse them in a minimum amount of distilled water. Bark, twigs and fruit may be subjected to the same test as the leaves. The number of leaves or amount of material necessary to use in order to obtain a test depends on the amount of nicotine present. In some of our own tests where five leaves gave a doubtful reaction, ten leaves gave a definite one. Generally we were able to obtain a definite indication of the presence of nicotine in as little as 25 cc. of water by using five leaves that had been sprayed at the usual strength (about .05 of 1 per cent nicotine).

After having rinsed thoroughly, filter and make filtrate slightly acid with a few drops of hydrochloric acid. If a precipitate is formed at this point, filter again. To this filtrate add several drops of 1 per cent silicotungstic acid. A white cloudiness denotes the presence of nicotine. It will be found convenient to conduct this test in a glass beaker over a dark surface.

We have found that silicotungstic acid obtained from J. T. Baker Chemical Co., Phillipsburg, N. J., or from Merck & Co., New York City, satisfactory for this purpose.

After making up the 1 per cent aqueous solution, settle and filter. This solution will keep indefinitely.

Combinations

This test has been applied successfully to aqueous solutions of "free" nicotine, nicotine sulphate solutions, nicotine-soap solutions, nicotine-arsenate of lead, and nicotine-Bordeaux. It has not been found effective in testing nicotine-lime-sulphur, as the presence of colloidal sulphur derived from the polysulphides seems to interfere with the test.

Discussion

The boiling point of nicotine is 247° C. (447.8° Fahr.). This is particularly significant in view of the popular belief that nicotine evaporates much more rapidly than water and that when the spray has dried and is no longer visible on the plants, the nicotine has by that time also disappeared.

When nicotine solutions are used for fumigating greenhouses, there are generally two or three more or less distinct periods of boiling. When aqueous solutions of nicotine are used, there are two distinct periods, in which the water boils off first and later the nicotine. When alcoholic solutions are used, there are three more or less distinct periods of boiling: First alcohol, then water, then nicotine.

It is true that upon evaporation, under ordinary temperatures, concentrated solutions of nicotine become *stronger*. A sample of nicotine sulphate containing 40 per cent nicotine kept in a tumbler exposed at ordinary room temperatures for about three months showed at the end of that time a nicotine content of 49.46 per cent. A small sample of "free" nicotine left in a shallow dish at ordinary room temperature for two weeks increased in nicotine content from 40.71 per cent to 94.82 per cent.

In evaporation of dilute solutions under ordinary temperatures, probably the same general condition exists; namely, that the water evaporates much more rapidly than the nicotine, resulting in a continually increasing concentration of the nicotine film on the sprayed parts of the plant, until finally a very highly concentrated though invisible film of nicotine remains. The actual amount of nicotine left may be so small as to defy any attempt to determine it quantitatively and yet may show quite distinctly in the qualitative test.

How this film would work as an insecticide is as yet a matter of conjecture. The general opinion has been that the film may act as a stomach poison in being eaten by chewing insects. On the other hand, some believe the "odor" or fumigation would have some effect. All of these are possible, but it is also quite possible that this film is effective as a direct contact insecticide, on larvæ as well as other stages. As the film is very much more highly concentrated than the

original nicotine strength applied to the plant, it is quite likely that the mere contact of parts of the body of various insects with this film would be fatal.

In conducting this test whole leaves should be *rinsed* (preferably by dipping and stirring each leaf separately, holding on to the petiole meanwhile) without breaking the epidermis. Otherwise organic matter within the leaf, going into solution, may give a test similar to the nicotine test. As checks, the water being used in the experiment should be tested as well as the unsprayed leaves.

A CLERID LARVA PREDACEOUS ON CODLING MOTH LARVÆ

(Second Note)

By D. E. Merrill, *State College, N. M.*

In the Journal of Economic Entomology, vol. VII, No. 2, April, 1914, on pages 251–252, appeared a first note on the clerid larva treated further below.

The larva in question was taken October 20, 1912. It was then nearly grown, judging by the sizes of later specimens. Below is its history as recorded:

October 20, 1912. Taken under a band on an apple tree. Placed in a glass jar with some bits of paper on some dry dirt. Given 6 codling moth larvæ.
October 17, 1913. Given 6 more codling moth larvæ.
June 18, 1914. Grown more hairy. Sluggish.
June 23, 1914. Fed 6 codling moth larvae.
July 8, 1914. All 6 larvæ put in last have transformed to moths. So the clerid ate none of these.
August 30, 1914. Transferred to a 4-inch covered Petri dish. Placed in dish some bits of paper and a "pupa stick" such as was used in the codling moth work at the Experiment Station for observing time of pupation. Given 8 codling moth larvæ.
September 7, 1914. Placed a second clerid larva in the dish. No. 1 very sluggish.
September 9, 1914. No. 1 was evidently starting to pupate when the second larva killed it and partially ate it, even when there were codling moth larvæ in the "stick."

In this period of nearly $22\frac{1}{2}$ months the larva had molted several times. Opportunity was not given to keep definite record of the molts of this or of later specimens. Only 26 codling moth larvæ were fed to the clerid larva in that time. Probably the first 12 were eaten. The 6 placed in the dish June 23, 1914, transformed to moths; 6 codling moth larvæ were found in the "stick" when the clerid died. Likely the two others of the last eight fed were eaten by the second clerid larva introduced on September 7, 1914. That leaves just 12 codling moth larvæ eaten in nearly two years.

The histories of 5 adults reared in the summer of 1915 are summarized below. The larvæ were all collected from codling moth bands on trunks of apple trees.

No. 1. This larva was the one mentioned as placed in the cage with the original larva on September 7, 1914. Pupation had taken place by May 30, 1915. An adult male clerid beetle emerged on June 14, 1915. In the approximate 9 months 17 codling moth larvæ were eaten.

No. 2. The larva of this specimen was taken with 8 others on December 30, 1913. All were about two-thirds grown. One adult female emerged June 14, 1915. One larva was alive, 7 had died in the $17\frac{1}{2}$ months since the 9 were taken. In that time 29 codling moth larvæ had been fed to these larvæ.

No. 3. The nearly grown larva of this specimen was confined alone on March 15, 1915. It had pupated by May 29, 1915, and an adult female emerged June 14, 1915. In 3 months it ate 4 codling moth larvæ.

Nos. 4 and 5. Two large larvæ were taken Jan. 19, 1914. Four others of about the same size were placed with these June 23, 1914. Two emerging adults were taken June 14, 1915 and placed in alcohol before completely out. The sex was not recorded. The 4 other larvæ were dead and all but 1 partly devoured. In the 17 months 34 codling moths were eaten by the six. It can not be decided if the two adults were the two placed first in the cage.

The adult male and two adult females were placed in a cage together on June 14, 1915. On June 15 the male and one female were found in coitu. The female had chewed a hole in the thorax of the male injuring him so that he died the same day. This day the female ate 1 larva and 1 pupa of *Autographa sp.* Two days later she ate the same amount. On June 26 she was fed 2 larvæ of the *Autographa* and several codling moth larvæ. She did not eat well and died August 23, 1915, after being in a very sluggish condition for about six weeks. No eggs were found.

To Prof. H. F. Wickham, Iowa City, Iowa, the writer is kindly indebted for the specific determination of the adults and for numerous helpful notes and citations concerning certain clerids. The species was given by Professor Wickham as *Cymatodera æthiops* Wolcott, the citation to the description being given as "Field Museum of Natural History Publication 144, Zoöl. Series, vol. VII, No. 10, p. 350, May 1910." "The type was from El Paso, Texas. The cotype from Tucson, Arizona, both collected by me," Professor Wickham states. Further he says, "Cymatodera is usually beaten from partly dead branches and shrubs, or found hiding under loose bark."

The writer has taken adults at lights at State College, N. M. The specimens hatched out in the laboratory here, however, solved the question as to what species to refer the larvæ preying upon the codling moth larvæ. The term "warriors" applied to these predators by Mr. Stuart, an orchardist near Mesilla Park, N. M., is a very fitting common name.

No data are at hand as to the behavior of the adults in the feral state. That they are predaceous is demonstrated by the specimens in captivity. One clerid pupa was found in April, 1915, under a band and in a codling moth cocoon. In the laboratory the pupal cells were made by chewing up and cementing together bits of paper, or, in some cases, bits of the pasteboard partitions in the "pupa sticks" in which the cells were made. The cell was well walled in. The pupal case was merely a silvery film investing the developing beetle.

There is still a question as to the actual length of the larval period. The specimens experimented with above were all well grown when taken. Possibly the food supply was not as constant as it would be in nature. However, the larvæ were able to go without food for a long period, which would indicate an adaptation to an uncertain food supply. One nearly grown larva in confinement was fed well from March 15, 1915 to June 26, 1915. Then it was fed no more but did not die until Nov. 20, 1916,—a fast of nearly 17 months. Sharp, in Camb. Nat. Hist., Insects, Pt. II, p. 254, records "a larva (of *Trichodes ammios*) sent to M. Mayet refused such food as was offered to it for a period of 2½ years, and then accepted mutton and beef as food. After being fed for about a year and a half thereon, it died." Again, on the same page, "one of its larvæ (*Trichodes alvearius*), after being full grown, remained 22 months quiescent and then transformed to a pupa." Certainly a blessed quality to possess in lean years!

There is a question, too, as to the specific economic importance of *Cymatodera æthiops* in relation to the control of the codling moth. The members of the family Cleridæ are as a whole carnassial, but, evidently, widely so. In the feral state this species probably would not confine its attacks to the larvæ of the codling moth but would likely take whatever food chance offered to its liking. Where bands are kept on apple trees in winter the food supply is made more constant and the protection greater for the clerids. Better chance is given, also, for them to kill more of the codling moth larvæ. At the same time, from several years of observation, they do not appear to be ever sufficiently numerous to clean up the bands and underlying bark of hibernating codling moth larvæ. So the bands serve as places of protection to the latter, if not removed after the hibernation is begun. If removed, the clerids are destroyed with the codling moth larvæ. Probably they search out under the bark some few larvæ that would go unnoticed and in so doing help a little to reduce the number of spring moths emerging. However, they can not be relied upon to such an extent as to permit omission of removal and examination of bands in winter, where banding is practiced.

If the larvæ of this clerid were more numerous by having a more

rapid succession of generations, or if they had keener appetites and a special liking for the codling moth larvæ, the benefit from them would be more appreciable. With their long developmental period, small numbers, and their feeding scattered, both as to kind of larvæ, and as to generations of the codling moth larvæ, the appreciably effective control work done by this species is reduced to a minimum.

February 6, 1917.

HIBERNATION OF THE HOUSE-FLY IN MINNESOTA[1]

By C. W. Howard, *St. Paul, Minn.*

The manner in which the house-fly (*M. domestica*) survives the winter is a matter which has drawn considerable discussion in the last few years. The older theory, that it is the adult fly which passes the winter, for some time gave place to the theory that the winter was spent in the pupal and possibly in the larval stage. The recent work of Bishopp, Dove, and Parman (1915), and of Dove (1916) shows conclusively that in a mild climate such as that of Texas it is possible for both larvæ and pupæ to pass the winter and adults to emerge in the spring. In cases of mild weather during the winter adults might emerge and oviposit. Nothing has been done to prove whether the same conditions hold for the colder northern regions such as Minnesota. Jepson, at Cambridge, England (1909), was unable to carry pupæ through the winter successfully. Newstead in 1909 stated that the most recently emerged flies in autumn may hibernate. On dissection such flies are found to have the abdomen packed with fat bodies in the autumn, but not so in the spring. In 1913 Hewitt confirmed these observations. In a later paper in 1915 Hewitt in some observations on the migration of fly larvæ made in the early spring near Ottawa stated that not a single living pupa was found in the manure or in the soil about the manure pile. He therefore returned to the older theory that the fly overwinters in the adult state in a dormant condition where there is sufficient shelter to protect it from a killing degree of cold, or in places where the temperature and food conditions are suitable to keep it periodically or permanently active. He suggests that the immature stages may survive the winter where temperature and food conditions are favorable, as will be often found in warm stables. Lyon in 1915 in Massachusetts was unable to secure the emergence of adults from puparia exposed to outdoor conditions over winter, although it was a mild winter.

That flies can be bred during winter under suitable conditions is a

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[1] Paper No. 78, Journal Series, Minnesota Experiment Station.

well-known fact, first brought to notice probably by Jepson in 1909 when he bred them in a greenhouse. Since the winter of 1914–15 flies have bred each winter in the animal room connected with the Minnesota University Insectary, the construction being such that the accumulation of material suitable for fly breeding can be scarcely avoided. Up to the winter of 1914–15 the same conditions held in the bacteriological animal house of the University. The droppings of rabbits and guinea pigs collected in corners and not being cleaned out for long periods, furnished breeding places for both *M. domestica* and a few *Stomoxys calcitrans*. Breeding places were also found under water dishes where the spilled water soaked the bedding thus setting up fermentation. Regular and more thorough cleaning quickly remedied this condition.

Several observations have been recorded to prove that adult house-flies are rarely taken in winter in buildings or other protected places. In 1913 Copeman reported on three collections of hibernating flies taken in England during March and April. Not a single specimen of the house-fly was found in these collections. In 1914 Copeman and Austen reported on fifty-eight consignments of hibernating flies sent to them from widely distant parts of England. Out of a total of ninety-four flies, twelve proved to be *M. domestica*. These were taken during January, February and March, each time in an active state in living rooms or heated rooms. Ashworth, 1916, states that no adult house-flies can be found in Scotland during the winter.

Since most of the observations on this subject have been made under climatic conditions somewhat milder than those found in Minnesota, with the exception of those by Hewitt at Ottawa (1915), data collected here during the past three years may be of interest.

Temperatures in Minnesota often reach $-25°$ to $-30°$ F. and remain below zero over considerable periods in mid-winter. Flies continue to breed in Minnesota until late in October or early November, the adults lasting until the first heavy frost in November when those die which have not been previously killed by *Empusa muscæ*. Individual adults of both sexes have been taken during the months of December, January, February, March and April, always in houses, or restaurants where temperature and food conditions would be favorable. In stables flies of several species begin to appear by mid-April as a rule, but the house-fly has never been taken among these early forms. A total of nineteen flies have been taken in this way, eleven females and eight males. These flies always looked fairly fresh with wings unbroken. The number seems almost negligible, but when we consider the limited field of observation of one or two people, there must be a fairly large number of flies thus surviving each winter. Flies do not

become noticeable before the middle of June or early July and are not abundant before mid-July. If only a very few survive the winter this would account for their later seasonal appearance.

To test the ability of adult flies to live throughout the winter the following experiments were conducted:

Just before frost appeared, on October 31, a quantity of larvæ and puparia were collected and about two hundred were placed in each of several jars, containing a little moist soil covered with a layer of fresh manure. These jars were placed in breeding cages and the cages in different places, where conditions were such as have been thought suitable for overwintering of the flies. As soon as the flies had emerged they were fed regularly with fresh banana and water. The places chosen were (1) a cellar where the temperature averaged 62°, the lowest recorded being 50°; (2) a stable at the dairy barn, where the temperature never went below the freezing point and only once during the winter approached that point, averaging 45°; (3) an unheated storeroom. Heat entered the latter through an open transom, keeping the temperature above freezing. In this room a large number of flies were also set free. In all six cages of flies were used in this test. Adults began to emerge November 11. In the cellar they were all dead by November 23. In the stable a few survived until February 6. In the storeroom a sudden fall in temperature on December 14 caused the death of all the flies. No thermometer was available to record the temperature, but it was above freezing. Several cages had also been prepared, packed with folds of cheesecloth in which flies could hide away. These were placed in various stable lofts and covered with hay. Where the temperature of the loft was that of the outdoors, the flies died as soon as the temperature approached freezing; in the lofts where the temperature remained higher the flies survived until early December by which time the weather had become cold enough to lower the temperature of the loft to near the freezing point.

During the summer of 1914 several attempts were made to find the reaction of various stages of the house-fly to low temperatures. As no constant temperature apparatus was at our disposal we secured the privilege of using a cold storage plant in town. Temperatures of 12°, 30° and 40° F. were available. Week intervals were necessary between examinations. Adult flies were placed in quart fruit jars containing strips of paper for supports and with cheesecloth tied over the top; larvæ and pupæ were placed in moist soil and manure in wooden boxes $3\frac{1}{2}$ x $2\frac{3}{4}$ x 2 inches in size. Several of these boxes were placed inside a larger one for convenience in handling. Twenty-five adults were in each jar and 100 larvæ or pupæ in each box. Exposures at 12° F. for one week were fatal to adults, but one male survived

exposure for one week at 30° F. and one female survived a week's exposure to 40° F.; all others died even with these short exposures. Of the larvæ, none survived a week's exposure to 12° or 30° F., but three larvæ survived one week's exposure to 40° F. and two adults emerged, the third dying. Longer exposures at 40° F. were fatal. Pupæ were killed in one week at 12° F.; at 30°, 23 survived and produced adult flies, but all died at longer exposure than one week; at 40°, 21 survived and produced adults, but none were able to endure more than one week of such cold.

The objection may be raised to this that the change from the outdoor temperature of July to that of the refrigerator was too sudden. The double packing of the cases would tend, however, to reduce this danger and make the change more gradual. It would seem from these observations that the house-fly in all its stages is very sensitive to low temperatures, a temperature of even 40° F. causing death if long continued.

To further test the ability of larvæ or pupæ to survive our winters, several thousand half-grown to full-grown larvæ were secured on October 15, 1915. An outdoor breeding cage 4 x 4 x 5 feet was transformed into a manure heap. Four twelve-inch flower pots were sunk in the soil and filled with fresh manure. Into these were placed the fly maggots, after which a covering of about twelve inches of fresh manure was placed over the entire floor of the cage. The larger maggots pupated very soon and large numbers of flies emerged before frost came. On May 15, 1916, after several *Lucilia* and *Sarcophaga* had emerged, the manure was removed and the contents examined. About 25 per cent of the puparia had not produced adults in the autumn previous, but in every case these had died and the contents begun to decompose.

In the springs of 1914 and 1915 careful searches were made about manure piles and compost heaps on the University Farm and elsewhere, but not a single live puparium was found in the manure or surrounding soil. In the spring of 1917 a third attempt was made to find puparia. The manure from the University Farm stables is placed in a compost heap which by autumn reaches a size of about two hundred feet long by three to ten feet high and fifteen feet wide. On April 17 a few puparia were found in the dry manure on the east edge of the pile, but more in the soil under the center, near the north end, where the manure was about three feet deep. They all looked quite fresh, some still possessing a ruddy or yellowish color. A total of 1,646 of these apparently live pupæ were collected and taken to the laboratory. By May 15 not an adult *M. domestica* had emerged, although one *Scatophaga stercoraria* and one *Sarcophaga sp.* had

emerged. Up to June 10 no adults were seen about the compost heap or in houses although a very few were present in the stables, averaging ten to twelve to a stable.

From these observations it would seem that the temperature of Minnesota winters is not favorable to the overwintering of the house-fly in any except the adult stage and that stage only in places where there is a sufficiently high temperature and where food conditions are favorable.

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AN IMPROVED METHOD OF REARING TABANID LARVÆ

By Werner Marchand,
Department of Animal Pathology of the Rockefeller Institute for Medical Research, Princeton, N. J.

The Tabanidæ are a group of considerable economic importance and it is desirable for the study of their bionomics as well as for experimental purposes to follow more practical methods in rearing them than has been the case up to the present. Only a few larvæ at a time have been reared by authors, and these were usually placed in damp earth to provide them with an environment as close to the natural one as possible. In fact, from De Geer (1760) to the more modern investigators, notably C. W. Hart (1895), J. S. Hine, who beginning in 1903 has studied the life-histories of several American species, Lécaillon in France, who studied *T. quatuornotatus*, and others, the larvæ have always been reared in damp sand. Hart seems still to have used breeding-cages or boxes of some size, while Hine is the first to propose jelly-glasses, as of more convenient size and having other advantages. In such jelly-glasses, the cover of which was perforated with a few holes, Hine succeeded in raising *Tabanus lasiophthalmus* from the egg to the adult. Of still more recent investigators, H. H. King (1910) and others have followed Hine's method with small modifications according to circumstances. S. A. Neave (1915) used vessels, made by the natives of the African locality where he made his studies, which were filled with damp sand in much the same way. Patton and Cragg, who wished to raise large numbers of Tabanidæ in India without giving much time to their feeding, proposed the use of trays of very large dimensions in which, even in the case of highly carnivorous larvæ, a certain percentage will reach maturity.

All these methods have the disadvantage that the larvæ are kept in sand and consequently cannot be conveniently observed. Their presence can be ascertained only by washing them out of their sandy habitat which takes considerable time and also disturbs the larvæ; small larvæ are easily overlooked and lost; larvæ in the act of pupation, or shortly afterwards when the pupæ are soft, are often damaged, etc. As, most of the time, the larvæ are not visible at all, details of feeding habits or molts of the larvæ have hardly ever been noticed and the exact time of pupation and consequently the duration of the pupal period could seldom be determined.

When beginning an investigation of the life-history of these flies, I found that the larvæ of a number of species, and probably of most of them, do not need earth or sand for their well-being, but can be kept very conveniently in test tubes laid out with a rolled-up sheet of filter

paper, somewhat less than the length of the test tube and filled with water to about one-half to one inch high, which is sufficient to keep the filter paper moist for a number of days. The test tubes used are about seven and three-quarter inches long with a rolled edge. To prevent the larvæ from escaping, a piece of cheesecloth is tied to the open end by means of a small rubber band.[1] The larvæ will often hide between the sheets of the paper or on the inner side of it, but about as often come to rest between the paper and the glass walls of the tube where they remain for days plainly visible in all their activities and where they can even be examined microscopically. Molts cannot be overlooked as the shed skins appear plainly on the white surface. In the same way excrements may be readily observed and taken out with the paper for examination. Earthworms may be given as food with the advantage that they move about in the test tube and are soon found by the larvæ, but meat proved an excellent substitute and was readily taken by all the larvæ under observation. This is of some importance as earthworms cannot always be had and the feeding problem then becomes difficult. Food should be given every two or three days but the larvæ can go without food for a much longer time.

Hine has stated that a disagreeable odor developing in the breeding jars seemed to be injurious to the larvæ. I have found, however, that the larvæ did perfectly well even in the presence of highly putrefactive and ill-smelling matter, and were not affected by the presence in the tubes of dead earthworms, decaying meat, etc. Nothing needs to be feared in this respect for the larvæ as long as they have air to breathe. In one case only a larva died, evidently in consequence of an infection, after remaining in contact with a piece of meat for several hours. In another case a pupa of *T. lineola* was seen in contact with a lump of decaying meat for several days and then moving away from it by itself. The larvæ will sometimes drown in the water of the bottom of the test tube, but even when apparently drowned will often revive when placed in air again.

I notice that M. B. Mitzmain (1913) in his excellent studies on *T. striatus*, placed larvæ in jars with sheets of filter paper which were partly soaked with mud. He also saw the larvæ congregating between the filter paper and the glass walls of the jar, and he is the only author who observed several molts in Tabanid larvæ. A. Lutz (1910) used damp moss instead of mud and glass vials to render the larvæ more visible; and test tubes have, as far as I know, been used by Baldrey (1913) who, however, did not raise many larvæ. The method here proposed, if not absolutely new, appears satisfactory enough to be recommended for more general use especially for the close observation

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[1] I find it convenient to keep the test tubes on wooden racks holding twelve each.

of single larvæ, although it would be cumbersome for rearing large numbers. Several dozen, however, can be taken care of easily by one worker with daily inspection of all the tubes.

The damp filter paper gives to the larvæ a perfect substitute for the damp mud in which they usually live and is also similar in contact, facilitating their natural movements upwards and downwards in the tube. They pupate without difficulty in the test tubes and usually in the upper portion of the roll of paper. Pupæ were obtained in this way from four species of Tabanus.[1] The pupæ are easily taken out of the test tubes and placed in other dishes or jars, but two males of *Tabanus lineola* were allowed to hatch in the test tube; of these one had the wings fully developed, and the other one had one wing slightly distorted, having been hindered in its development by the filter paper which had become dry and somewhat hardened. Larvæ of 4 to 5 mm. in length did just as well as those of 40 mm. and more in length. The filter paper is taken out from time to time with a forceps and renewed, but if one wishes merely to keep the larvæ alive and to rear the adults, this may be omitted and all that is necessary is to keep the filter paper moist and to give new food from time to time. When the paper becomes dry or the larvæ are very hungry, they will sometimes succeed in escaping by creeping underneath the cheesecloth in spite of the rubber band holding it, but this happens only occasionally. In fact, the larvæ need very little care and with this rather simple breeding apparatus, it should be a comparatively easy task to obtain detailed data on the life-history of any Tabanid species.

Test tubes have already been used for the rearing of Dipterous larvæ, notably by J. P. Baumberger, for rearing *Drosophila ampelophila* on agar, but for earth- and mud-inhabiting larvæ a convenient method was lacking. The test-tube-and-filter-paper method may prove useful for the rearing of many such larvæ, as those of Tipulidæ, Stratiomyiidæ, possibly of Lampyridæ, etc.

A few words may be added here about collecting the larvæ. I have first followed the method employed by Patton and Cragg, who recommend using a pail in which mud and sand from the edges of rivers and ponds is mixed with water and thoroughly stirred and the muddy water then sifted. Those larvæ which are able to float appear very soon at the surface; the others have to be obtained by sifting. Finding it inconvenient to wander about with a spade and pail, taking samples from different localities, I soon contented myself with an ordinary kitchen sieve by means of which excellent results may be obtained with very little trouble. Moderate-sized lumps of mud and sand,

[1] Since this paper was written, pupæ were obtained of fourteen species of various Tabanidæ: Tabanus, Chrysops, and Haematopota (?).

always taken above the water line but not far from it, are placed with the hands or by means of a small hand shovel into the sieve and worked over somewhat. As soon as the sandy constituents have been washed away the Tabanid larvæ become visible. The sieve need not be excessively fine as even small larvæ instead of going through the meshes will usually cling to the vegetable detritus, grassroots, etc., contained in the mud. As Tabanids are rather common in some localities and the larval stage, being of much longer duration than the imago, is more likely to be found, it will usually take less than half an hour sifting on any pond, brook or stream to find at least a few small-sized larvæ. One need not be discouraged about taking even the smallest ones as the slowness of their growth has been much exaggerated; it is not slower, for instance, than in many lepidoptera with a one-year's life-cycle.

For transportation, the larvæ should not be placed in water but in some wet material in which they can hide. Unless abundant food is given, the larvæ should be isolated because of their cannibalistic habits.

AN INFESTATION OF POTATOES BY A MIDGE[1]

(Diptera, Chironomidæ)

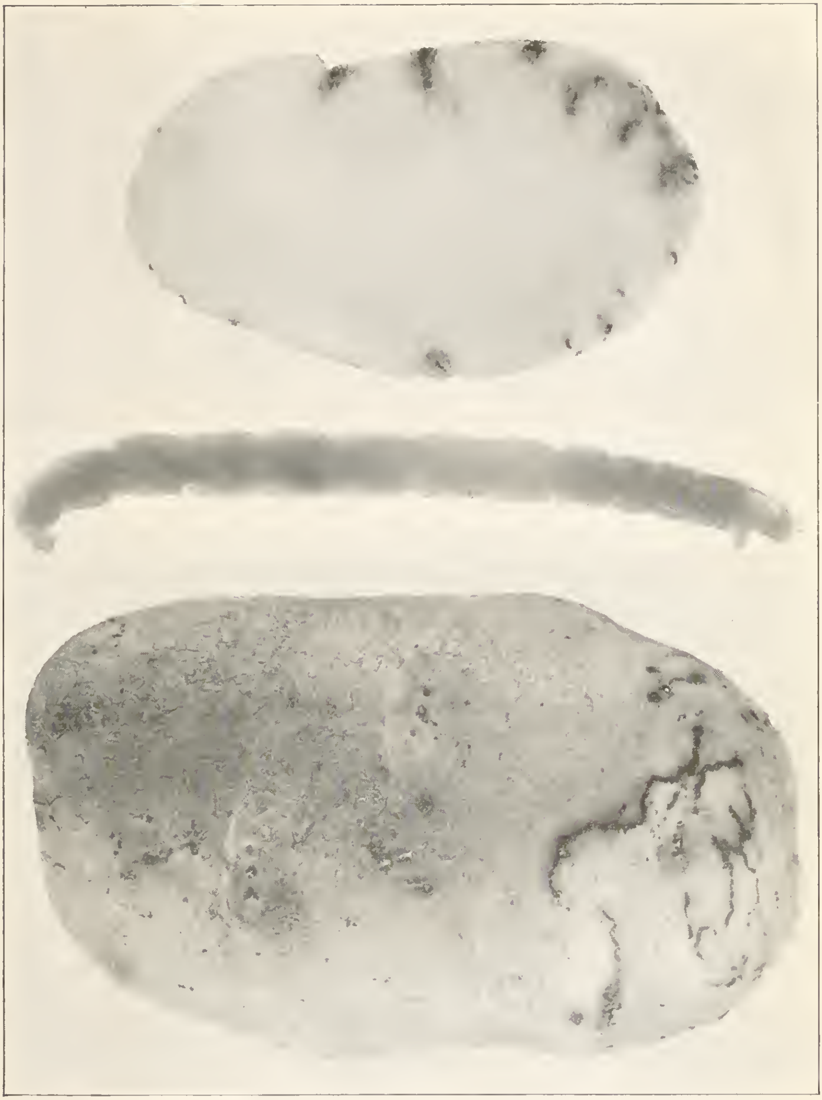
By Edith M. Patch

A record of a Chironomid larva, in the rôle of a potato miner, may be of sufficient interest to justify transferring it from the notebook to the printed page.

On October 25, 1913, potatoes of the appearance shown in the accompanying photograph were received from Roxie, Maine, with the statement that they represented the condition of an infested acre. The trails contained numerous dipterous larvæ so different from any pest known to the writer that it was at first suspected that they had worked into mines made by something else and that their presence was accidental. That such was not the case was testified by the larvæ themselves when a cut tuber was placed under the microscope. The exposed miners were busily tunneling down into healthy tissue. As they worked they moved the ventral flap under the head up against the mouthparts. Some of the trails lay under the skin near the surface of the potato and were apparent as soon as the tuber was washed. Others extended for some distance into the vegetable, as is shown in the figure of the potato cut in half.

The larvæ were three-sixteenths of an inch in length. They were

[1] Papers from the Maine Agricultural Experiment Station: Entomolgy 92.



Larva of Chironomid greatly enlarged, and its work in potato.

abundant in the trails, where frequently as many as fifteen or twenty could be found together in the wider places, though the narrow mines seemed to be the work of single individuals.

On the chance of the situation proving serious, the case was reported to the State Department of Agriculture and a barrel of infested potatoes was requested by the Station for study. The following quotation is from a letter by the grower of the potatoes:

"Have sent you today by express a barrel of the potatoes, as directed. In answer to your questions will say: The seed was bought of a farmer about four miles away from this place last year and planted on this farm but not on the same field. Bought them for Gold Coins but they are mixed with other varieties. Had no trouble with them last year. This acre was between two other kinds neither of which seemed to be affected. The land was in hay four or five years and was broken last spring (1913) for potatoes and used Armour's fertilizer. Was top dressed in 1911 with barn yard manure. . . . There are two other farms near here where potatoes affected in the same way have been found."

The maggots lived in this shipment of potatoes for a fortnight or so but no pupæ were obtained and by the middle of November none but dead larvæ were found.

A specific determination was not possible on the data presented, but Dr. O. A. Johannsen kindly examined the larvæ and pronounced them "probably *Camptocladius* sp."

No similar occurrence has come to the attention of the writer since this record for 1913 and it is hoped that the attack was due to some peculiar local condition which may not again prove favorable to this midge in its career as a serious pest of potatoes.

THE COCOANUT-TREE CATERPILLAR (BRASSOLIS ISTHMIA) OF PANAMA[1]

By L. H. Dunn, *Entomologist, Board of Health Laboratory, Ancon, Canal Zone*

Cocoanut culture on the Isthmus of Panama may be safely ranked as an important industry, and bids fair to become more so in the future. At the present time in nearly all parts of Panama cocoanuts are grown to a greater or less extent, ranging from the few trees near a native's hut to large and profitable groves, covering many acres of ground and owned by large companies.

For numerous reasons this industry on the Isthmus does not have

[1] Read before the Medical Association of the Isthmian Canal Zone, January 22, 1916.

the commercial importance that it is likely to have in the future. More people will come here following the successful operation of the Canal, to engage in agricultural pursuits and it is safe to say that a great many more cocoanuts will be exported than at the present time, as they are one of the safest products to handle in Tropical America provided facilities for transportation and shipping to the markets are convenient.

After the young trees in a grove are well started the principal care required is to combat the insects that are injurious to them, as the trees in this region are singularly free from the diseases that cause much damage in other parts of the country and it is with one of the injurious insects that this article is concerned.

The most destructive insect enemy of the cocoanut tree, *Cocos nucifera*, in Panama is the lepidopterous insect, *Brassolis isthmia*, in its larval or caterpillar stage. This insect is a native of Panama and as far as can be ascertained is found in no other region.

I have been studying this pest twice a year (seasonally) for the past two years, but for the most part only during spare hours, and have not been able to devote the amount of time to this work that is necessary to make a thorough investigation of their habits, and also have not had the opportunity to do much field work in this connection which is highly essential in a life-history, but I will endeavor to set forth a few results obtained from work done at the Laboratory and observations I have been able to make on the cocoanut trees in the Ancon Hospital grounds.

History

Brassolis isthmia was first recorded and described by Bates[1] in 1864. It belongs to the genus Brassolis, which, according to Westwood,[2] contains four species that are very closely allied, but differ in their habitat. *B. isthmia* is recorded only from the Isthmus of Panama. *B. sophoræ* is found in British Guiana, and *B. astyra* in Brazil. I have not been able to secure much information regarding the habitat of the fourth species, *B. macrosiris*.

In 1908, Shultz[3] published an excellent article on *B. isthmia* giving information regarding their life-history, habits, and damage caused by them, which is the only information on the life-history of these pests to be found in the literature at hand.

[1] Bates, The Entomologists Monthly Magazine, vol. 1, p. 164, June, 1864.

[2] Doubleday & Westwood, Diurnal Lepidoptera, vol. 11, p. 350.

[3] Shultz, Henry F., Proceedings of the Entomological Society of Washington, vol. X, March–June, 1908, p. 164.

General Description

Egg.—The eggs are somewhat spheroidal in shape, or slightly flattened on two sides. They are about one millimeter in diameter, and average in weight about 1.4 milligrams each. When newly deposited they are white with a yellowish tint.

Larva or Caterpillar.—The newly hatched caterpillar is red in color, the shade becoming reddish brown over the head. The body is only about half the diameter of the head. If examined with a lens they may be seen to have three narrow light colored stripes extending from the head to the posterior segment. The young caterpillars are about 4 millimeters in length and 0.5 millimeter in diameter. The diameter of the head is approximately one millimeter. The average weight about two hours from time of emergence from the egg is one milligram. When full grown the caterpillars range from 7 to 10 centimeters in length, and 10 to 12 millimeters in diameter. The weight, when mature, varies from 2½ to 4 grams. The head is quite large and prominent and is hard and shiny, the color being from red to dark brown. The apex and center of the head being lighter in color than the cheeks. It is somewhat longer than wide, being about 7 to 9 millimeters long and from 5 to 7 millimeters wide. The body tapers slightly to both ends and has a ground color of dark brown, ornamented with three yellow longitudinal stripes running the full length of the body, one stripe on the dorsal surface and one on each lateral surface. The stripe on the dorsal surface is about 4 millimeters wide, with light colored outer edges, and the center having minute lighter colored spots, giving the center of the stripe a slightly freckled appearance. Each stripe on the lateral surfaces has two thin intermediate dark colored stripes running the full length and the outer portion of the stripe having the freckled appearance as the one on the dorsal surface. Each of the segments are ringed with thin light colored markings which can be noticed upon close examination. A number of fine short brown hairs are scattered over the body as well as many longer white ones. The dorsal surface of the caterpillars vary in color from light red to dark brown (according to the age) and the red color changes to brown when nearing the pupal period.

Pupa or Chrysalis.—The chrysalis during the first few days of pupation varies in color from light gray to a faint purple, with many darker markings of dark brown on the head and wing covers. The abdomen is rounded dorsally and pointed at the posterior end, and has one regular stripe varying from light blue to brown running the full length of the chrysalis from the head to the end of the abdomen, with a faint blue irregular stripe on each side. Four dark brown stripes on the ventral side extend from the wing covers to the end of the abdomen. The segments near the base of the wing covers are somewhat telescopic in character and allow a considerable amount of motion. The chrysalis is smooth and somewhat shiny and is from 2½ to 3½ centimeters in length, and from 10 to 15 millimeters in diameter, and averages in weight from 2½ to 3½ grams. The female chrysalids are somewhat larger than the males.

Imago or Butterfly.—The butterfly is dark brown in color on the dorsal surfaces of wings, thorax, and abdomen; all ventral surfaces being several shades lighter. A pale brownish yellow patch, one centimeter wide, extends across the fore wings from the costal margin to within a very short distance from the anal margin. This patch has a small angular spot of dark brown extending into it from the costal border. The ventral surfaces of the fore wings have the same yellow patch that is seen on the dorsal surface, and also has a narrow convoluted line, with dark edges, extending along the lateral margin of the wings. The ventral surface of the hind wing has three small round spots, arranged at nearly right angles, several shades lighter than

the surrounding area; the spot in the anal angle being the largest and having a narrow black margin, and small shadings of white within the front border of the black margin. The body is densely hairy. The female butterfly has a wing expanse of from 9 to 10 centimeters. The antennæ are from 15 to 18 millimeters in length and slightly bulbous at the tips. The legs are dark colored and the anterior pair are short and held folded and apparently not used in any way. The gross appearance of the males differ from the females by being a shade lighter in color, and the angular dark spot in the yellow patch on the dorsal surfaces of the fore wings is fainter. The circular spot on the anal angle of the ventral surface of the hind wing is also somewhat smaller than that of the female.

Injury Caused

This pest is only injurious to the cocoanut tree while it is passing through its larval or caterpillar stage, at this time their food consists of the leaves of the tree. These caterpillars form long bag shaped nests of the leaflets by fastening the ends together and spinning a silken lining on the inner side and live in great numbers in these nests. It is safe to estimate that the average nest contains about 400 caterpillars, and as the average tree only has from 15 to 30 leaves it is needless to say that if left in the tree the full grown caterpillars living in one nest will very quickly either completely defoliate a tree leaving nothing of the leaves but the large main stalk and the slender midribs of the leaflets, or destroy enough of the foliage to cause serious injury to the tree.

In beginning an attack upon the long leaflets the caterpillars invariably commence to feed at a point about half way between the end that is fastened to the main stalk of the frond and the free end of the leaflet. The eating of the borders on either side of the leaflet to its midrib at this point, even though the entire width is not severed, soon causes the outer end to wither as it interferes with the circulation of the juices beyond the place where the caterpillars do their feeding. Frequently it eats its way through the midrib of the leaflet and this completely amputates the distal end which falls to the ground and is never utilized as food for the insect. Thus in three ways it may bring about the destruction of the leaflet, *i. e.*, consumption of the entire leaflet; amputation of distal half of the leaflet; and interference with the circulatory system of a portion of the leaflet. In many instances nests may be located in trees by the appearance of the ground beneath it. The ground below a large nest of full grown caterpillars is sometimes nearly covered with the ends of leaflets that have been severed at the middle. Through this habit of feeding at the middle of the leaflets, the caterpillars destroy about as much foliage by wastage as by actual consumption of the frond.

It is by no means uncommon to see large trees almost entirely denuded of their foliage, and after a severe attack by these cater-

Cocoanut-tree caterpillar: 1 male; 2 female; 3 caterpillars in prepupal stage and chrysalids; 4 caterpillar.

Cocoanut-tree caterpillar: 1 nest; 2 nest opened.

pillars it requires several years for a tree to recover, if it recovers at all.

In many instances solitary high trees seem to be the most heavily infested, but this may be due to the fact that as the trees are standing alone, some of the females of the previous broods that have lived in the trees deposit their eggs in the same trees without seeking further for a suitable place, and the young caterpillars emerging from the eggs of several females are found to live in one tree in greater numbers than if they were in a thick grove and were able to spread to other trees.

The caterpillars show a decided preference for cocoanut trees and the injury is nearly always confined to the cocoanut palms, but at times they will also attack other trees of like nature. They have been noticed feeding on the Royal palms, but so far no nests have been found in any of these palms that were low enough to examine closely, although in several trees the caterpillars were quite numerous and were generally found during the daytime on the under side of the leaves, or in the pocket at the base of the leaf stalk. From this it would appear that the caterpillars leave the cocoanut trees to seek a suitable place to pupate, and when the palms are selected feed upon the leaves for a few days before pupating.

If one had an opportunity to closely examine the grown Royal palms an occasional nest might be discovered, although there are not likely to be many as no appreciable damage caused by these caterpillars has yet been noted in the Royal palms, at least in this locality.

Life-History and Habits

There are two broods a year of these pests. In the spring the adult females deposit their eggs during May and June, and in the fall during the latter part of October, the whole of November, and the early part of December. It is very evident that the different stages greatly overlap each other, as eggs, grown caterpillars, and adult females ready to oviposit, may often be found during the same day.

In many instances the eggs are deposited on the lower side of the leaves, or on the trunk of the cocoanut trees, but numbers are also found on buildings, or other sheltered places, from which it would appear that the female was more concerned in seeking protection for the eggs from the weather and parasitic enemies, than for a place suitable for the young caterpillars to obtain food upon their emergence.

The eggs are laid in masses, made up of both regular and irregular rows of the eggs. The eggs in one mass may be all in regular rows, and in a second one may be all in irregular rows, while a third mass may be one part regular and the other part irregular rows. Apparently there is not much uniformity in the arrangement of the egg masses. They are laid in very close order and are cemented to each

other and to the surface on which they are deposited by a clear mucilaginous substance which gradually changes to a dark brown in color after it has been exposed to the air for a few days.

The number of eggs in a mass vary considerably, ranging from 150 to 300. This difference in numbers would lead one to suspect that in many instances the female does not deposit all her eggs at one time, but only deposits part in one place and later finds a suitable place to deposit the remainder.

The portions of the eggs not heavily coated with the cementing substance is white with a yellowish tint when first deposited but becomes grayish in color after a few days' exposure to the air. About 3 to 5 days before hatching a small dark spot appears in the center of each egg.

The egg stage extends over a period of from 25 to 30 days duration. At the end of this period the young caterpillars eat their way out of the egg shells and emerge head first.

The caterpillars that have emerged from all egg masses that have been hatched in the Laboratory have eaten the egg shells and all the gummy material used in fastening the eggs together soon after they have emerged. Nearly all parts of the shells are eaten excepting the part cemented to the leaf or surface to which they are fastened. Eggs from which the young caterpillars have not yet emerged are not eaten by those already hatched.

When bred in jars the young caterpillars after making their first meal on the shells from which they have emerged soon begin to travel around the sides of the jar in lines of single file, each close behind the other, and leaving a small trail of silk behind them. This is continued sometimes until the inside of the jar is about completely lined with silken floss.

During this stage when the newly emerged caterpillars that have hatched away from a cocoanut tree are endeavoring to reach their food supply, a great many are undoubtedly destroyed by birds, toads, lizards, ants, etc., and it is not likely that very many ever do succeed in reaching a cocoanut tree, and those that emerge from eggs deposited on the trees are the ones that are responsible for the greater amount of damage done, and for the succeeding generations, but even if a very few of the young traveling caterpillars do reach a tree that is not already infested they can lay the foundation for a considerable amount of damage.

For some time after emerging the caterpillars do not seem to cause any appreciable amount of damage, but as they continue to grow the damage likewise grows in proportion, and when full grown the numbers in a large nest can destroy nearly all the foliage on a tree in a few nights, and it is at this time that they attract attention the most.

Before reaching maturity they always gather in large numbers and build nests for themselves. This nest building habit of these caterpillars appears to be peculiar to themselves as there seems to be no record of any other lepidopterous insects utilizing leaves to form a nest to the same extent as the *B. isthmia* does.

The nests are formed by bringing the ends of the leaflets on opposite sides of the main stalk of a leaf together so that they extend downward, and at the lower end the narrowness of the leaflets give to the whole affair the appearance of a long funnel shaped bag. The leaflets are fastened together with a silken web spun by the caterpillars and they also line the entire nest with an inner lining of this silk. Many of the large nests are divided into several compartments by having partitions of this silken floss extending longitudinally in the nests. This inner lining of silken web does not reach to the ends of the leaflets forming the nest, thus leaving openings at the bottom for all the excrement within the nest to drop to the ground.

As the leaflets of a cocoanut tree extend at nearly an obtuse angle it evidently requires considerable skill to bring the ends down and together in order to fasten them in the positions they occupy in the nests, and this is probably accomplished by the weight of large numbers of the caterpillars.

Close observation of this nest building has so far been impossible. The low trees which would permit of such observation have been remarkably free from infestation, and for the higher trees neither the time nor the necessary conveniences have been available.

One nest recently examined was 4 feet and 4 inches in length and 14 inches in width at the top, measuring over all the leaflets fastened together. Thirty-three leaflets were fastened together to form this nest, 16 on one side and 17 on the other.

The number of caterpillars found in a nest varies greatly, ranging from as low as 50 up to as high as 2,000. Apparently a great deal depends upon the size of the nest and the time that it is cut down. Undoubtedly, in a small nest, many of the caterpillars, finding their quarters overcrowded, emigrate to large nests in close proximity, or there may have been only a small number to start with when the nest was begun. Nests that are cut down late in the season are liable to contain smaller colonies than those found earlier, as they are then full grown and many may have already left the nest to find suitable places for pupation.

In the particular nest just mentioned, 615 caterpillars were found. All were full grown and ready to pupate and there were probably many more that had left the nest to pupate before it had been cut down.

Usually there are but one or two nests to be found in a tree, but

there may be as many as five or more in a large tree that is badly infested. Five were found in one tree recently, three of these were large and each probably contained several hundred caterpillars, the other two were both small ones.

It is possible that these nests are built as a protection against the hot tropical sun and heavy rains. Some of them seem to be nearly watertight as several recently examined were cut down shortly after a heavy rain and in each one the inner sides of the nest and the mass of caterpillars inside were found to be quite dry, but this is not likely to apply to all the nests as some have been found that were poorly built, and late in the season as the caterpillars begin to reach their maximum growth they quite often eat large holes in different parts of the nests.

The caterpillars are nocturnal in habits and remain in the nests during the day and come out to feed only at night time. They may be observed during the daytime only late in the season when they leave the nests and begin seeking a place suitable for pupation.

Owing to the height of the trees and this habit of hiding during the daytime, the caterpillars would not be noticed in a tree thick enough to hide the nests, except for the ends of the leaflets on the ground under the nests and the destruction of the leaves, unless a close search was being made for the nests.

In the spring they usually attract attention about the latter part of February or March, by the leaves being so badly eaten that they are readily noticeable. In the fall they are noted about July or August.

All of the caterpillars hatched in breeding jars died before the first molt, and owing to the fact that none could be reared to the chrysalis stage it was impossible to ascertain the number of molts during the caterpillar stage.

They complete their growth in about four months. The fall brood sometimes extends over a longer period of time. Of course much depends upon the food supply and temperature and humidity may also play a part in governing this period of their life.

During April (in the spring) and September (in the fall) the large full-grown caterpillars begin to leave the trees and seek places to pupate. They can then be observed traveling along the walks and roadways at a rapid gait. Even at this period they show a desire to avoid the bright sunlight as much as possible, and when crawling on a walk or road or any place cleared of grass and shrubbery seem to be moving quite rapidly, but when in the grass or bushes to hide them from the light they lessen their gait and travel more slowly.

A few of the caterpillars remain in the trees and pupate there, but these represent only a small percentage of the whole number. Those

that do pupate in the trees usually attach themselves to the trunk of the tree or outside wall of the nests, and seldom are found as chrysalis inside the nests or in the pockets formed by the base of the leaves.

The large numbers that leave the trees seem to select a variety of places in which to pupate, such as beneath the overhang of roofs, under boards on fences, on verandas, trees of different kinds other than cocoanut palms, and in fact they are found in all manner of out of the way places. The principal point that they appear to have in view is a place that is dry and protected from the weather.

When about to transform to a chrysalis the caterpillar fastens itself to any under or side surface by the posterior end with a webbing of fine silk and hangs head downwards. It seems to require about 24 to 48 hours for this transformation. During the first 12 hours the caterpillars hang curled up and slowly contract longitudinally and swell out at the upper or anal end. As the chrysalis forms inside and draws away from the head of the caterpillar skin it leaves the lower head end of the skin empty and collapsed. After about 12 hours or more the larval skin starts to split lengthwise down the dorsal surface and the round portion of the chrysalis begins to emerge and by a sharp jerking motion soon endeavors to free itself from the cast skin. This may sometimes be loosened from the chrysalis and fall to the ground, or other times it may hang attached to the webbing of silk, holding the chrysalis to the wall or place of attachment, and dry up.

After just pupating, the chrysalids often have a light red tinge to their color which gradually darkens as they become more mature.

The length of the chrysalis stage is from 14 to 17 days. At the end of this period the shell splits and the adult butterfly emerges.

Out of one lot, consisting of several hundred of these caterpillars, that was collected and placed in separate jars and bred out in the Laboratory, 53 per cent of the adults that emerged were females, and the remaining 47 per cent males. Seventy-eight per cent of the males had a 15-day chrysalis period, and 68 per cent of the females had a 16-day chrysalis period. This would tend to show that the males emerge a little earlier than the females. The chrysalids that are late in the season seem to have a day or two shorter period than when pupating earlier in the season.

For the first few hours after emerging the adult clings to the empty chrysalis case until its wings become dry and straighten out, and it is then ready to begin its existence as an adult.

Since the eggs begin to form in the females during the chrysalis stage at about the sixth day, the adults emerge with eggs almost fully developed and it only requires copulation to fertilize them and then they are ready to be deposited.

The female butterflies can readily be distinguished from the males as soon as they emerge from the chrysalis case, because the large number of eggs contained by the female greatly distends the abdomen. The chrysalids, near the time for emergence, offer some evidence of sex differentiation since the females are larger than the males.

Few of the adults are to be seen in flight excepting at night or late evening, and are then sometimes seen in numbers. The few that are to be noticed in the daytime are generally females and are supposedly seeking a place to deposit their eggs. It has been impossible to obtain any data on the feeding habits of the adults.

There appears to be a variation in numbers between the spring and fall broods. In some seasons the spring broods are the greatest in numbers and do the most damage and the fall brood may be very small, and the following year it may be the opposite and the greatest damage may be caused by the fall brood. This difference may probably be caused by the methods of control applied and also be influenced by the action of parasitic enemies.

The fall broods seem to have a slightly longer caterpillar period, but as they are in this stage during the dry season of the year in Panama, it may be that this tends to lengthen the period.

Preventive Measures

Methods of control such as spraying, etc., that ordinarily proves effective with leaf eating insects in the Temperate zones are almost impossible in this case. While these caterpillars are leaf-eating and should be susceptible to stomach poisons, their environs render the application of such poisons as expensive and useless procedure.

The spraying of cocoanut trees is impractical in Panama especially during the rainy season, and the height of full-grown trees causes spraying to be tiresome and extremely difficult at any season. It is either necessary to use long extension pipes with a nozzle on the end and these are generally so unwieldy that it is difficult to direct the spray. Long ladders might be used with a man at the top of the ladder with a short spray pipe connected with a rubber hose to the pump. This is also an unhandy manner of working as the man is then directly under the foliage to be sprayed. In either case a very strong pressure is required to give necessary force to the solution at such a height. Even if a spray could be applied by some easier method the sudden and heavy rains so common in this region would be liable to wash it off almost as soon as applied.

Owing to the nesting habits of these caterpillars and to their remaining hidden within the nests during the daytime, if a little care is exercised they may be kept under complete control by the removal of the nests with the caterpillars inside.

When trees are infested with these pests the most practical method of disposing of them is by going up in the trees by means of long extention ladders that will reach to the tops of the trees and cutting down the nests without disturbing the occupants. They can then be crushed with heavy mortars, or a better way is to throw the nests containing the caterpillars on a hot fire. They may also be killed by dipping in a strong contact insecticide.

While cutting out the nests is about as troublesome as spraying, if done at the proper time it is only necessary to be performed once during a season and will give the most reliable results.

When spraying is the method employed every tree would have to be gone over in order to be effective and to prevent the caterpillars from leaving a sprayed tree and emigrating to one that was not treated, while nest removals require attention only to the infested trees that may be found. The principal point to be observed in cutting out the nests is to be on the lookout and remove them at the proper time. They should be removed early and before the caterpillars have become fully grown. If they are neglected until the caterpillars have become mature many will have left to pupate by the time the nests are removed and naturally will develop into adult butterflies and propagate the following season.

Cutting down the nests is the method that has been adopted with the cocoanut trees in the Ancon Hospital grounds and it seems to have proved effective.

Banding the trees with a sticky substance may prove to be of some value in preventing the young caterpillars that emerge from eggs that are deposited in places other than the trees, from gaining access to them. This may be done by painting a ring about 18 inches wide around the trunk of the tree at some distance from the ground with a thick coat of tar or other sticky material of like nature that is sufficiently waterproof to withstand the heavy rains. This should also be done at the proper season when the young caterpillars are emerging from the eggs.

Natural Enemies

The natural enemies of the cocoanut tree caterpillar may be classified as follows: Insect-feeding birds; lizards; insect parasites; and a fungus disease.

It is very evident that many of the young caterpillars are destroyed by insect-feeding birds, both while on the ground and also while in the trees before the nests have been built to form a refuge for them during the daytime. They are not only eaten by the adult birds but are also carried to the nests as food for the young. As neither the English sparrow or the North American robin are to be found here in any

numbers the birds that come first as insect feeders in Panama are a species of blackbird, but it is not likely that more than a small percentage of each season's brood are destroyed by birds.

As lizards are insectivorous in their feeding habits to a large extent, is reasonable to suppose that they also destroy many of the young caterpillars by eating them while they are on the ground and also while they are in the trees and before becoming too large, as several varieties of lizards are often to be found in the trees seeking for insects to feed on.

The caterpillars are nocturnal and are most active at night-time, or while in dark places, and it may be supposed that many of the young ones that emerge from eggs away from the trees, and while endeavoring to reach the trees, and also many of those that are full grown after leaving the trees and while on the ground seeking a place to pupate, fall an easy prey to toads, as they are very numerous in this region, and are both insect feeders and feed largely at night as well. Toads that were in captivity ate eagerly of half-grown caterpillars when given to them.

Parasitic insects undoubtedly destroy a larger percentage of *B. isthmia* than any of their enemies just mentioned and may be classed as second in importance of their natural enemies as a control of this pest. These parasitic enemies destroy the B. *isthmia* while they are in the chrysalis stage. Some of the parasitic flies deposit their eggs or living larvæ either on, or near enough to, the chrysalis so that the young larvæ may enter it without much trouble and feed on the soft-bodied insect and destroy it. Other flies inject their eggs directly into the chrysalis and the young larvæ emerge from the eggs inside and promptly proceed to devour their host.

The adults of these parasites come under two orders, the Hymenoptera or four-winged flies, and the Diptera or two-winged flies. The small Chalcid flies are the principal hymenopterous parasites, and the dipterous parasites belong to the *Sarcophagidæ* and the *Tachinidæ*.

Unfortunately none of these parasites are peculiar to the *B. isthmia* alone, they are simply accidental or occasional hosts, the flies selecting them as food for their larvæ as they might select chrysalids of many other lepidoptera belonging to different families.

It is to be deplored that the caterpillars have an opportunity to do all their damage before pupating and allowing these parasites a chance to get in their work, but at any rate they help to decrease the brood the following year.

The most important of all the natural enemies is a fungous disease that attacks both the mature caterpillar and the chrysalis. This fungi causes a high mortality among these pests every season, espe-

cially during a period of heavy rainfall or when they are exposed to much dampness. The fall brood seems to suffer a heavier loss than the spring brood, which may be accounted for by the fall brood becoming mature during the middle of the rainy season of the year and there is a much heavier rainfall than when the spring brood are in evidence.

Many are found dead in their nests of this disease and are generally found either in the bottom of the nests, or hanging from the sides suspended by the second or third pair of prolegs and the anterior and posterior ends of the body hanging downward in the shape of a horseshoe. Nearly all of the dead caterpillars become heavily coated with this fungus a short time after death, while the chrysalids become very hard on the inside from the heavy growth of the long filaments of the fungi.

Observations were made on one lot of about 1,000 caterpillars that were collected and placed in a small screened house during the fall season. This house is about 6 feet long by 3 feet wide, and $6\frac{1}{2}$ feet high. Three sides are made of wire screening and the fourth of sheet iron. The roof is made of corrugated iron with screening beneath, which serves to keep the rain out. There is free ventilation in this house and it is comparatively dry with the exception of the floor which is of dirt and becomes quite damp during heavy rains.

Of this lot of caterpillars that were under observation over 65 per cent died as a result of this fungus invasion without changing to chrysalids, and about 50 per cent of those that did transform into chrysalids died in the chrysalis stage. This is a much higher rate of mortality than is likely to be found in a spring brood. It was noted that nearly all of the chrysalids killed by this fungus that were dissected and examined and found to contain females had died before egg formation had begun to take place, and as the eggs can generally be observed in a female after the sixth or seventh day, it would appear that the chrysalids die within the first few days of the chrysalis period. A few were found that contained eggs and these had evidently died later.

It is safe to believe that quite a large proportion of each season's brood are destroyed by their natural enemies.

Laboratory Observations of the Parasitism

In order to discover whether the parasites infest *B. isthmia* in the caterpillar or chrysalis stage considerable observations were carried on at the Laboratory. Shultz[1] in speaking of the parasites says, "I

[1]Shultz, Henry F., Proceedings of the Entomological Society of Washington, vol. X, No. 1–2, March–June, 1908, p. 166.

have not been able to find out whether the mature parasite deposits its eggs cutaneously into the caterpillar, or into the chrysalis, or whether its ova are introduced into the alimentary tract of the larva with its food, as I have found the parasitic larva only in the chrysalids." To determine this point on the parasitization, large numbers of the caterpillars were collected and bred out. Each season when the nests were cut down from the trees several large ones were secured and hung up in the screened house already mentioned and closely observed for signs of parasites. When secured the caterpillars were nearly always mature, which would have afforded ample opportunity for any eggs of the parasites to have been deposited on the skin, or to have been eaten, if that was the manner in which they were parasitized. As soon as pupation began cotton sheeting was tacked around the sides of the house over the screening to prevent any flies from depositing their eggs or larvæ through the screen onto any of the chrysalids that were attached to the screening. Out of approximately ten thousand caterpillars that were collected to be bred out in this manner during different seasons, not a single parasite was found either in the caterpillar stage or in the chrysalids that had transformed inside the house, although all the dead caterpillars and chrysalids that died of fungus or from other causes were carefully dissected and examined. This alone would show that if any were parasitized in the caterpillar stage the percentage must be very small. Aside from this, the fact that the caterpillars remain hidden in the nests during the daytime for the greater part of their lives would help to exclude any chance of being parasitized during this stage.

As proof that the chrysalis is the form attacked, as many of the chrysalids as could be found were collected each season and a large percentage were found to be infested with either dipterous or hymenopterous larvæ. In 1914, during September and October, 106 chrysalids that had pupated out-of-doors in different places were collected and placed in separate jars to breed out. Judging from the time that some of the adults subsequently emerged and from the fact that many had been allowed to remain outdoors for several days after being found, before they were taken inside, the chrysalids had probably passed from 6 to 9 days out-of-doors in the chrysalis stage. Out of this number, 20 were collected from cocoanut trees. Adult butterflies emerged from 14 of this lot, 3 died of fungus, and 3 were destroyed by dipterous parasites.

Sixty-nine were collected from outbuildings in the rear of the Laboratory containing rabbit hutches and small animal cages. These buildings are about ten feet distant from a cocoanut tree and seem to be a favorite place for pupation. Forty-five adults emerged from

this lot, 10 died of fungus and 12 were destroyed by hymenopterous and dipterous larvæ.

Ten were collected from within the courtyard and verandas of the Laboratory. Adult butterflies emerged from 6 of this lot, 1 died of fungus and 3 were destroyed by hymenopterous and dipterous larvæ.

Seven were collected from trees other than cocoanut trees. Adult butterflies emerged from 3 of this lot, 2 died of fungus and 2 were killed by hymenopterous and dipterous larvæ.

The total number destroyed by fungus was unusually small, but being brought into a dry room and placed in separate jars may account for this.

Out of the total of 106 chrysalids, 69 emerged as adult butterflies, 17 died of fungus, and 20 were killed by hymenopterous and dipterous larvæ. Of the 20 destroyed by the parasites, 11 were killed by hymenopterous larvæ, and 9 by dipterous larvæ.

Many other experiments to test the susceptibility of the chrysalids to dipterous larvæ were carried out. Two of these may be worthy of mention. On October 5, a large gravid female fly, *Sarcophaga* sp., was captured on the window in the room where a number of caterpillars and chrysalids were confined in breeding jars.

This fly was placed in a small jar with a caterpillar that was in the prepupal stage, and was curled up and ready to cast its skin in a few hours. On the morning of October 6, the caterpillar had cast its skin and changed to a chrysalis. On October 7, the adult fly was dead, and many young larvæ could be seen crawling on the chrysalis and cast skin, and many more were found feeding on the chrysalis beneath the wing covers when the covers were slightly raised. On October 16, nothing remained of the chrysalis but the empty case, and the larvæ began pupating, and by October 18, had all pupated. Nineteen adult flies emerged during October 22 and 23, and 6 more emerged later on October 25. The whole 25 flies had lived on this one chrysalis during their entire larval period of from 9 to 11 days.

A caterpillar was collected on October 2 and placed in a small breeding jar, and it changed to a chrysalis on October 5. On October 6, a large gravid female fly, *Sarcophaga* sp., was captured on a window in the same room and placed in the jar with the chrysalis of less than 24 hours. On October 7, the fly was dead and one small fly larva was noticed crawling on the chrysalis. On October 8, this larva could not be seen, and no further evidence of any fly larvæ was noticed until October 24, when the chrysalis was examined and found to be but an empty case, and upon being opened 3 dipterous pupæ were found inside. Two of the adult flies emerged October 28. No adult emerged from the third pupa.

These two instances would show that fly larvæ such as *Sarcophaga*, or other omnivorous larvæ, find no difficulty in entering the chrysalis under the wing covers during the first few days of the chrysalis stage and before the wing covers begin to fit tightly around the edges.

There seems to be a peculiar odor to the chrysalids that attracts flies, and a dead chrysalis proves to be a still greater attraction. Dead chrysalids that happened to be left in uncovered jars and were afterwards examined and dissected were in many cases found to contain large numbers of larvæ of the small flies of the *Phoridæ* family, and the adult flies could be noticed flying around the jars in large numbers after dead chrysalids were left uncovered for a few days.

From work carried out it appears to be definitely proven that this pest is parasitized during the chrysalis period and is free from parasites during the entire caterpillar stage.

Owing to unavoidable causes these observations on *B. isthmia* have not been as complete as could have been wished, but they cover the ground as thoroughly as the circumstances would permit.

I wish to express my thanks to Dr. S. T. Darling, former Chief of Laboratories, for his advice and assistance during nearly the whole of this work; to Major F. F. Russell, Chief of Laboratories, for examining and making cultures of the entomogenous fungi of this pest; to Dr. H. C. Clark for making pathological examinations of chrysalids killed by this fungus disease, and to Mr. J. E. Jacobs, Chemist, for determining all weights given in this paper.

NOTES ON THE LIFE-HISTORY OF MARMARA ELOTELLA BUSCK, A LEPIDOPTEROUS SAP FEEDER IN APPLE TWIGS[1]

By Stuart C. Vinal

For several years the writer has observed quite noticeable serpentine mines in the bark of apple twigs in the vicinity of Amherst, Mass. In 1914 a sample of this work was sent to Washington for determination, and identification showed the sap feeding larva responsible to belong to the genus *Marmara* of the Tineina but the adult moths had never been reared from apple. Accordingly, at the suggestion of Dr. H. T. Fernald, investigation was started during the winter of 1915 with the object of obtaining adult insects and studying the life-history. In July some moths were bred from the apple twig mines and sent to Mr.

[1] Contribution from the Entomological Laboratory of the Massachusetts Agricultural College, Amherst, Mass. This paper is presented as part of a thesis for the degree of Master of Science.

Busck of the National Museum, who identified them as *Marmara elotella* Busck.

Special acknowledgments are due Dr. H. T. Fernald, Dr. G. C. Crampton, and Dr. W. S. Regan for their encouragement and assistance throughout the progress of this paper. For the identification of this species and helpful suggestions the writer is deeply indebted to Mr. August Busck of the United States National Museum and to Rev. J. J. DeGryse of Staunton, Virginia.

History and Ecology

The Tineina, to which this species belongs, constitutes a large and important group of minute moths including many destructive miners. These fall roughly into two distinct classes according to their manner of feeding.

1. Tissue feeders. Those which feed on the internal parenchyma tissue of leaves early in life and later may become external feeders.

2. Sap feeders. Those which mine just beneath the cuticle destroying only a few layers of cells and feeding on the plant sap thus liberated.

This sap-feeding habit has been found only in two families, the Phyllocnistidæ and the Gracilariidæ. The Phyllocnistids are sap feeders throughout their larval life and include the following genera: *Marmara*, *Camermaria*, and *Phyllocnistis*, while the Gracilariids in their early instars are true sap feeders but in later instars become tissue or external feeders and include the genera *Gracilaria*, *Ornix*, *Acrocercops*, and *Phyllonorcyter*.

Many interesting articles have been written based on the specialization shown by these sap-feeding larvæ and their significance in showing evolutionary steps from the more generalized tissue-feeding type. The sap feeders are considered a very highly specialized group and are probably of comparatively recent origin in the Lepidoptera.

Practically all miners confine their feeding to foliage, but a few larvæ of the genus *Marmara*, established by Clemens (*Proc. Ent. Soc. Phila.*, vol. 2, 1863–64, pp. 6–7) mine just under the epidermal layer of bark. Clemens described *Marmara salictella* which "mines the bark of yellow willow tree" and gave a brief account of its life stages. He also described *Marmara* (*Gracilaria*) *fulgidella* (*Proc. Acad. Nat. Sci. Phila.*, 1860, p. 6) mining in twigs of white oak and chestnut. Chambers described *Marmara* (*Phyllocnistis*) *smilacisella* (*Cin. Quar. Jour. Science*, 2, p. 107) bred from leaves of smilax. This species was redescribed with biological notes added by Braun (*Ent. News*, vol. 20, p. 432, 1909). Busck described a new species, *Marmara guilandinella* (*Proc. U. S. Nat. Mus.*, vol. 23, p. 245), mining leaves of *Guilandia*

bonducella in Florida, and in *Proc. U. S. Nat. Mus.*, vol. 26, p. 772, he described *Marmara arbutiella* mining leaves of arbutus trees in Seattle, Washington. In *Proc. Ent. Soc. Wash.*, vol. 8, p. 97, he also described *Marmara opuntiella* mining leaves of Opuntia sp. in Southern Texas. *Marmara* (*Gracilaria*) *elotella* was likewise described by him in *Proc. Ent. Soc. Wash.*, vol. 9, p. 102, but the host plant was not given. A *Marmara* sp. mines orange peels in southern California but the adult has never been determined.

Clemens (*Proc. Ent. Soc. Phila.*, vol. 2, 1863–64, pp. 6–8) claims that *Marmara salictella* changed from the flat mining larva to a more cylindrical form which has fairly well developed legs and prolegs, and escapes from its mine to spin its cocoon in some convenient protected place, this cocoon being covered with a characteristic globular or frothy ornamentation. Busck also ascribes the above habits to *M. opuntiella*, *M. guilandinella*, and *M. arbutiella* although no actual observations were made on the last named species. *M. fulgidella* and *M. smilacisella* it is also claimed form the frothy characteristic cocoon of this genus. *Marmara elotella*, however, differs from all the above species in regard to the formation and situation of its cocoon.

Present Distribution in Massachusetts

An examination of apple twigs at various points throughout Massachusetts has indicated a rather widespread prevalence for this species within the state. It has been found more abundantly, however, in apple trees on the grounds of the Massachusetts Agricultural College and orchards adjoining, than elsewhere. The reason for this localized occurence is unknown.

Character and Extent of Injury

Infested apple twigs show the long, narrow, tortuous, serpentine mines which are very characteristic of all *Marmaras*. They are readily recognized by the yellowish-brown color and slight swelling of the bark over the tunnels, while the normal bark is dark brownish in color. The moths seem to prefer two-year-old twigs upon which to oviposit, usually selecting sucker-like growths. However, the larvæ are occasionally to be found mining in any branch which has a thin, smooth, epidermal covering. The mouth parts of the larvæ are profoundly altered and specialized for living beneath the cuticle of the bark, which they separate from the "greenbark" below by cutting through a row of cells by the action of their circular, saw-like mandibles. From the origin of each mine the tunnel gradually widens from about 0.5 mm. at the beginning, to 7–8 mm. as it nears completion. The average length is between two and three feet. These tunnels do not penetrate

deeply enough to injure the cambium and therefore this species is of little economic importance. Mines similar in character, undoubtedly caused by different species, were seen during the summer of 1916 on poplar, ash, and pine.

Life-History and Description of Life Stages

Egg.—Description:

Oviposition took place during the month of August while the writer was away, and hatching had occurred before his return so that only the empty egg shells have been available for examination. Judging from these the eggs are elliptical in shape, flattened below and convex above. Approximate measurements: 0.7 mm. in length. 0.5 mm. in width.

Location on the Tree.—These tiny eggs are deposited singly on the smooth bark of apple twigs, oviposition for the most part being upon two-old-year wood, and never on the present season's growth. They are apparently stuck to the bark with a secretion of a mucilaginous nature. Eggs are rarely laid upon older wood excepting where the bark is thin and smooth. The period of incubation is probably about ten days.

Mining Larva.—Description of Full-Grown Mining Larva (Fig. 24, 1):

Length 5.5–6 mm., width at first and second segment 1 mm. Dorso-ventrally depressed, body strongly constricted behind the second segment, the remaining segments tapering gradually posteriorly and deeply incised laterally at their junction points. Body semi-transparent, lemon-yellow in color and consisting of thirteen segments excluding head.

Head large, flat, slightly retractile, with dark chitinous supports. Mouthparts very much modified and exserted (Fig. 24, 5). Labrum (lr) fused with dorsal surface of head and immovable. Mandibles (md) large, flat, and circular saw-like with the distal margin serrated. Labium (li) consisting of a chitinous fold distally covered by short spines and extending far back into the head. Maxillæ rudimentary, situated in close apposition to the lateral sides of the labium at its junction with the head. Antennæ (ant) situated on each side of the head near the mouthparts, consisting of two visible segments, the distal one bearing two papillæ, one large and one small, two large papillæ present on second segment with a small one situated in close proximity to a bristle which extends to the apex of the antenna. Ocelli (oc), two pairs with lenses absent, situated posterior to the antennæ. On the lateral margin of the head mid-way between the antennæ and the posterior margin of the head is a stout spine.

Body. First and second segments widest, approximately 1 mm. Third segment narrower than second and fourth. An internal chitinous shield extends from the posterior border of the head into the prothorax and gives this segment a dark brownish color. No legs or prolegs present. Semicircular fold, probably used in propulsion, situated at the posterior extremity. Body without bristles except on first, second and third segments (thorax) where there are two short, stout spines laterally. Anterior fourth of each body segment banded by closely set spine-like protuberances of the body wall. These are directed backward and probably function in bracing the larva during tunneling operations. Spiracles extremely minute but visible with

high power of microscope, near the anterior lateral border of each abdominal segment except the last two. Meso- and meta-thoracic segments (second and third) without spiracles. Prothorax with a spiracle somewhat larger than those upon the abdomen, situated on each side near the posterior margin.

Larval Life-History.—It is very difficult to gather data on these interesting sap feeders because the larvæ if removed from their mines are unable to reënter the bark to continue mining and therefore soon die. On hatching, the young larvæ, without exposing themselves, immediately enter the twig and begin their mines which extend partly around the twig before running lengthwise. They molt twice before winter sets in and hibernate as third instar larvæ in their mines, protected from severe climatic changes only by the dead bark covering the tunnel. With the coming of warm days in the spring they resume activity and molt a third time about the middle of May. During June the fourth instar mining larvæ become full grown.

Hypermetamorphism.—In this species all the mining larval stages are flat, legless, with exserted mandibles fitted only for separating the tissues of plants and not for masticating purposes. In structure all these stages are alike excepting in the proportionate size of the thorax and abdomen. In the young larvæ the head and thorax are much wider in proportion to the abdomen than in later stages.

Upon reaching maturity the mining larva retreats a short distance and remains quiescent at one side of its mine. During this quiescent period the larval skin remains intact while internally a hypermetamorphic stage is formed, called the intermediate or pseudo-pupal stage. The head of the intermediate stage is formed within that of the mining larva and gradually contracts until the outline of both are readily seen under the microscope. In the meantime the body has gradually become shorter and more cylindrical. The formation of this intermediate stage has been excellently discussed by Rev. J. J. DeGryse (*Proc. Ent. Soc. Wash.*, vol. 18, p. 164, 1916) who observed this phenomenon in *Marmara fulgidella* Clemens.

Within the pseudo-pupal stage is formed the true spinning larva or pre-pupa, and when complete it emerges, casting both the intermediate and mining larval skins at the same time. This is accomplished by forcing its head backward and breaking the skin of both preceding stages transversely at the first abdominal segment. The head and thorax are first liberated, followed immediately by emergence from the abdominal exuviæ.

Spinning Larva or Pre-Pupa (Fig. 24, 2):

Length 5 mm. Color yellowish-brown with tinge of red. Body shorter, more cylindrical, and incisions between segments less pronounced than in mining larva.

Head smaller and more typically lepidopterous than in previous stages (Fig. 24, 6). Chitinous supports reduced in number. Mouthparts markedly different from mining

larval trophi. Labrum (lr) immovably fused with head and bears near its anterior edge six short spines. Mandibles (md) flat, well developed, with median margin serrated, and cross each other similar to the blades of a pair of scissors. In this species their function is still obscure. Maxillæ (mx) present, consisting of three visible segments; a large papilla-like terminal segment bearing laterally a spine near its tip; at the internal distal end of the basal joint are two long bristles which probably correspond to the lacinia of other lepidopterous maxillæ. Labium or spinneret (sp) well developed with labial palpi present. Antennæ similar to those of the mining larva but bear two long bristles on the second joint instead of one as in the mining larva. Ocelli, two pairs with lenses present. On lateral border of head five bristles, three situated near the ocelli and two just anterior to the junction of the head and prothorax. Three more bristles are visible from dorsal view which arise from ventro-lateral margin of head, two near the ocelli and one near the posterior border of the head.

Body. With the exception of the head the body wall of each segment is covered with spine-like processes, like those found on the anterior fourth of each body segment of the larva. From the side of each segment projects a fairly long bristle, with the exception of the first and last two segments which bear two each. A pair of rudimentary legs on each thoracic segment (1, 2 and 3) and a bilobed structure on the ventral side of the last abdominal segment which may function as anal prolegs or may be only a part of the thirteenth segment. No true prolegs of any kind. Last three abdominal segments shrunken and drawn forward.

Formation and Situation of Cocoon.—Heretofore all species of this genus have been described as emerging from the mines and spinning their cocoons in protected crevices, and according to Clemens and Busck, characteristically ornamented by frothy globules.

As mentioned above, the mining larva upon reaching maturity remains quiescent at one side of its mine and gradually becomes more cylindrical during the process of forming the intermediate pseudopupal stage, resulting in an upward pressure upon the epidermal covering of the tunnel which finally splits away from the twig at the opposite side of the mine. In all probability the mining larva weakens the epidermal covering with its mandibles before entering the quiescent stage. As the epidermis breaks away the spinning larva emerges and soon spins a few threads which help cause the cuticle to shrink and form a longitudinal fold under which the white, unornamented silken cocoon is spun (Fig. 24, 7).

Upon completion of the cocoon the spinning larva transforms to the pupa, which occurs during the latter part of June and early July. The spinning larva exuvium is very delicate and shrinks to form a compact ball at the posterior end of the cocoon.

Pupa (Fig. 24, 3):

Length 3.5 mm., width 0.7 mm. Newly formed pupa pale yellow showing a reddish tinge beneath the dorsum of the third, fourth, and fifth abdominal segments, but later becoming brownish with black markings on the wings. Proximal part of the labial palpi not covered by maxillæ. Maxillæ more than half the length of wings and longer than prothoracic legs. A very stout spear-like projection covered with blunt

teeth situated medianly on the front of the head, doubtless enables the pupa to pierce or saw through the cocoon on emergence. Appendages not fused to the body. Metathoracic legs and antennæ equal in length and reach to the last abdominal segment. Two pairs of bristles present on the thorax, one pair laterally on the dorsum of both the meso- and meta-thorax. A smaller, stouter bristle is situated on the lateral sides of the abdominal segments dorsal to each spiracle. Spiracles situated on anterior lateral margins of the abdominal segments project as tuberosities. The anterior fifth of each abdominal segment is banded by spine-like projections similar to those found in the larva and pre-pupa but less distinct. Cremaster absent. Last four abdominal segments movable.

Emergence of Adult.—Just previous to the emergence of the adult, the pupa works its way forward, puncturing the cocoon with its spear-like projection and forcing itself half out of the cocoon. In this position the pupa case splits, liberating the tiny moth. This takes place in the vicinity of Amherst, Mass., from the middle to latter part of July. The duration of the pupal stage is at least fourteen days.

Adult (Fig. 24, 4):

"Labial palpi white, second joint dark fuscous exteriorly; maxillary palpi white on the inner side, fuscous exteriorly. Antennæ white, annulated with brown. Face, head and thorax shining silvery white. Fore wing white with golden-brown and black markings; at the base of the wing is a brown costal spot, on the middle of the wing is a golden-brown transverse fascia, broader on the costal edge than on the dorsal and edged posteriorly by a sharp black, somewhat angulated line; at apical third is an outwardly strongly oblique fascia attenuated towards dorsum and edged posteriorly with black, and a similar fascia also edged with black, but hardly so oblique is situated between this and the tip of the wing. Across the cilia and the extreme tip of the wing is a transverse streak of mixed brown and black. Fore and middle legs with swollen black femora and white tarsi. Hind legs white, shaded externally with brown; tibiæ smooth.

"Alar expanse: 6 to 7 mm."—Busck's description of *Marmara* (*Gracilaria*) *elotella* in *Proc. Ent. Soc. Wash.*, vol. 11, 1909, p. 102.

At the end of this description Mr. Busck states that this species is very close to *Marmara* (*Gracilaria*) *fulgidella* Clemens, and on comparing the two descriptions I find they practically coincide. However, Mr. Busck has made slide mounts of the male genitalia of *M. fulgidella* and *M. elotella* and has found that the two species are abundantly distinct. The fact that *M. fulgidella* mines in the bark of white oak and chestnut, while *M. elotella* mines in apple, coupled with their distinct genitalia proves that these are different species, but, nevertheless, are difficult to separate by descriptions.

As a supplement to the original description of *M. elotella* the following notes are added:

Fore and middle femora black at both ends. Distal end of middle tibia black and bearing two scale-covered spines which are usually black at base and white apically. Tarsi either white or marked with black at the distal end of each segment. From near the base of hind tibia originate two white scale-covered spines, the larger one

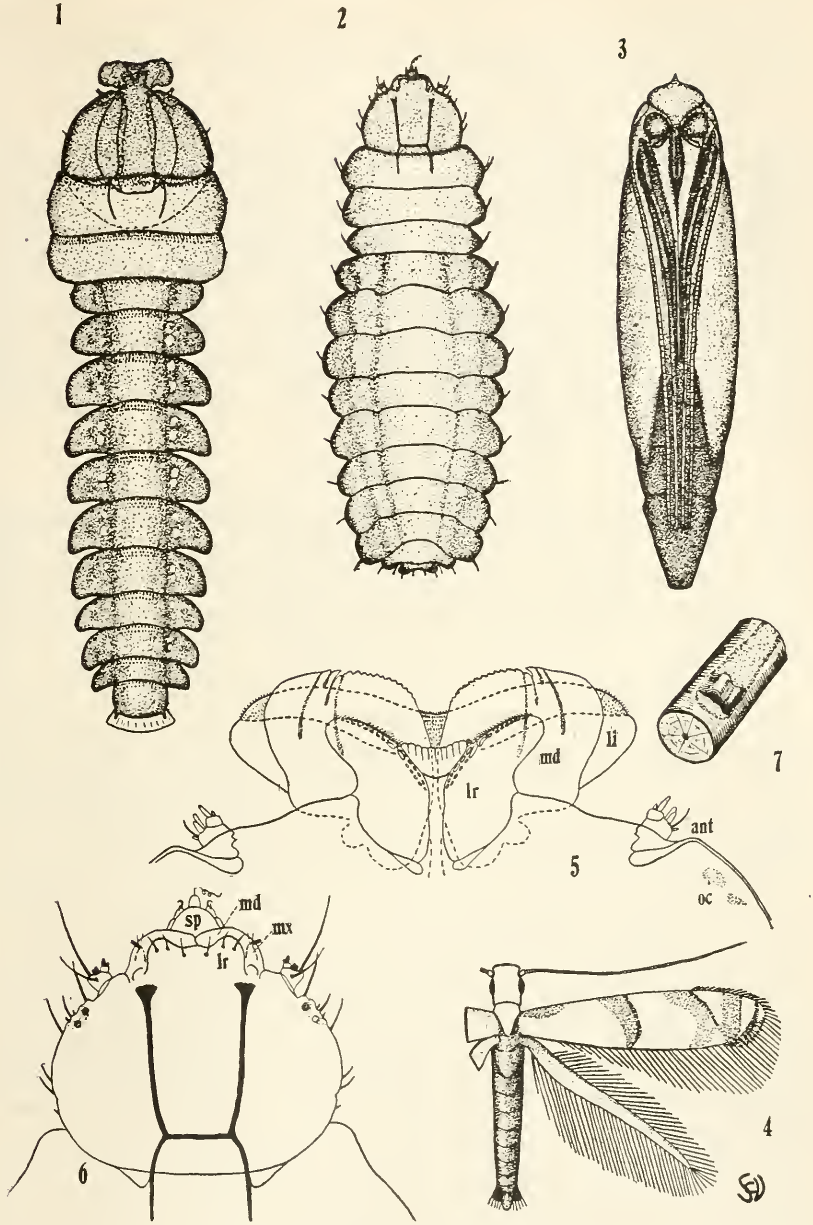


Figure 24. 1, Full grown larva; 2, Spinning larva or pre-pupa, 3, Pupa; 4, Adult. Head, thorax and wing coloration: White, white; Stippled portion, golden-brown; Short black lines, black. 5, Mouthparts of the larva. Labrum (lr); Mandibles (md); Labium (li); Antennæ (ant); Ocelli (oc). 6, Head of spinning larva or pre-pupa. Labrum (lr); Mandibles (md); Maxillæ (mx); Labium or spinneret (sp). 7, Twig showing epidermal fold under which the cocoon is spun.

banded in middle with brown. Two white scale-covered spines arise from the distal end of the hind tibia. Abdomen sometimes wholly white but more generally the anterior fifth of each segment is fuscous.

Habits of the Adults.—These tiny moths are very inconspicuous and, like other members of the group, assume a peculiar attitude while at rest. The fore legs are extended while the others are partly folded under the body. In this way the insect rests on the fore legs and the end of the abdomen. The antennæ are held at right angles to the axis of the body and are in constant vibration. During the day these moths are seldom active and remain hidden until dusk, at which time they may be seen flying around their host tree in quite large numbers during early August. In the course of a few days they begin laying eggs for the next generation. Thus it takes a full year for *Marmara elotella* Busck to complete its life cycle.

Natural Enemies

An undetermined Chalcid parasite is quite efficient in controlling these miners. Many of the larvæ become full grown and spin their cocoons but instead of containing the lepidopterous pupæ, the pupæ of the Chalcid parasite appropriates the comfortable quarters of the sap feeders.

General Considerations

Although adult characters of *Marmara elotella* correspond to the systematic ideal of the genus, the peculiar method of cocoon formation when taken in comparison to the characteristic Marmaran cocoon, which is ornamented by froth-like globules and has been observed in all species thus far described, shows that one of two things should be done. Either the generic cocoon character must be changed so that it includes the type shown by *M. elotella* or a separate genus should be erected. As stated elsewhere in this paper, I have observed bark miners on pine, ash, and hemlock which form the same characteristic cocoon as *M. elotella*, all of which will probably prove to be different species. Another fact showing difference between this species and other members of the genus may be found in that there are no prolegs in the spinning stage of *M. elotella*, while in other species the prolegs are present.

NEW SPECIES OF ECONOMIC MITES

H. E. Ewing, *Iowa State College, Ames, Ia.*

In the following paper seven species of mites are described. Six of these species are injurious, some being quite serious pests, and one species is beneficial, being predaceous. Of the seven species described, six are new, and the remaining species, *Tarsonemus pallidus* Banks (?), may prove to be new in the future. This species, which is the one that seriously injures cyclamens, does not agree with Mr. Bank's description of *pallidus*, but probably is the species described by Banks, as specimens agree fairly well with material determined by Banks as *T. pallidus.*

Tetranychus uniunguis n. sp.

A greenish yellow species. Palpi rather stout, reaching the tip of tibia of leg I. Palpal claw rather short, strongly curved and not very sharp at its tip. Thumb of palpus stout, as broad as long, reaching, but not surpassing, the palpal claw; finger of thumb situated in the middle of the apex, about twice as long as broad, and rounded at its tip. Hairs of thumb distributed as follows; two small ones on the inside of thumb near its apex, one long hair, about as long as the thumb itself, on the inside near the base, and another of about equal length on top not far from the base. Cheliceræ each arising near the base of plate, and making an evenly rounded loop posteriorly, and then passing forward for about two-thirds their length, then in a downward direction to their tips. The only place that the cheliceræ are swollen is near their bases. Tarsus of leg I considerably longer than the tibia. Tarsi each ending in a single claw, which is not strongly curved, but is very sharp; two tenent hairs. Length, 0.59 mm.; width, 0.42 mm.

From Urbana, Illinois; on arbor vitae (*Thuja occidentalis*); by the writer.

Tetranychus multidigituli n. sp.

Preserved specimens yellowish. Body somewhat depressed, skin more or less wrinkled, and abdomen somewhat pointed behind. Palpi prominent; claw, strong and much curved; thumb stout, almost as broad as long, and not surpassing the claw; digit or finger about half as long as thumb and less than half as long as broad; digituli, or spines, at least five near the tip of thumb, setæ also present on thumb. Mandibles, or cheliceræ, slender, with a simple loop toward base, and of uniform diameter except at base where they are slightly swollen. A single pair of eyes present, placed laterally; cornea strongly curved. Abdomen clothed above with rather stout, simple, slightly curved setæ. Legs moderate; tarsus of leg I about one and a third times as long as tibia, and truncate at its tip, from which springs a very long tactile seta. Tarsal claws rather weak, strongly curved near their bases, beyond which they are divided into six prongs. Onychium with four tenent hairs. Length, 0.30 mm.; width, 0.21 mm.

From Wooster, Ohio; on bark of honey locust, *Gleditsia triacanthos;* by J. S. Houser. Several specimens. This species differs from most of the other species in the genus in having several digituli, or setæ, to

tip of thumb; in having the setæ of the body relatively short and of about the same length, and in having the tip of the tarsi broad and truncate.

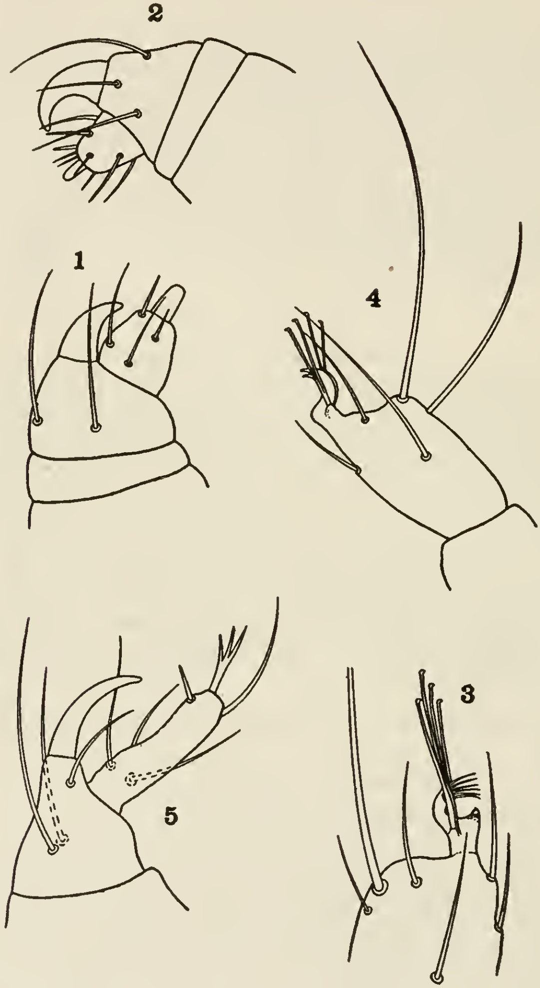


Fig. 25. 1, *Tetranychus uniunguis* n. sp. Tip of left palpus from the inside; 2, *Tetranychus multidigituli* n. sp. Tip of right palpus from the inside; 3, *Tetranychus multidigituli* n. sp. Tip of tarsus showing claw and onychium; 4, *Schizotetranychus latitarsus* n. sp. Tarsus of leg I from the outside; 5, *Caligonus mali* n. sp. Left palpus from the inside.

Schizotetranychus latitarsus n. sp.

Preserved specimens yellowish and reddish with dark spots showing through the body wall. Cephalothorax fully as broad as long. Mandibular plate, or rostrum, over twice as long as broad. Apparently two eyes on each side of cephalothorax,

but only one with a perfect cornea. Palpi prominent; palpal claw very short, stout, and but slightly hooked; thumb swollen, short, not reaching tip of claw, and apparently without digit. Abdomen rather strongly arched, and evenly rounded behind except for the anal papilla. Above, the abdomen is sparsely clothed with long, prominent, slightly curved, minutely pectinate setæ. Legs moderate; tarsus of leg I but slightly longer than tibia, very broad and truncate at its tip; at its tip above it bears a large tactile seta much longer than the tarsus itself. The tarsi of the legs are each provided distally with two subequal, simple claws, and four tenent hairs; of the latter the two inner are longer than the two outer, and all are at least twice as long as the claws. Length, 0.36 mm.; width, 0.23 mm.

From Pasadena, California; on bamboo; by C. P. Clausen. Described from several specimens. This species is probably an introduced one.

Caligonus mali n. sp.

Preserved specimens yellowish and reddish, but live ones brighter with more red. Body oval, about twice as long as broad. Palpi long, reaching about the middle of tarsus I; terminal segment about as long as segment next to it, and ending in a long, downwardly curved, sharp, simple claw. Thumb of palpus cylindrical, slender, surpassing the claw by about one-fourth its length and bearing at its tip a prominent, straight spine, 3-partite at its tip and about one-half as long as the thumb itself, and just below this prominent spine a longer, curved simple seta. Cheliceræ with stout bases, but tapering rapidly toward the slender, sharp, needle-like distal portions. Tips of cheliceræ reach to the distal end of femur of palpus. Abdomen somewhat pointed toward apex, sparsely clothed above with practically straight simple setæ. Legs moderate; anterior pair slightly longer than the others; posterior pair extending for fully one-half their length beyond the tip of the abdomen. Each tarsus is armed distally with two equal claws, between which is a delicate onychium, or pulvillus, composed of a central, longitudinal part from which springs several slender, downwardly projecting seta-like elements. Length, 0.30 mm.; width, 0.16 mm.

From Hillsboro, Oregon; causing a silvering of the leaves of the apple. The apple branches which the writer examined were badly infested and damaged by this mite. Serious injury to apple leaves was reported from Hillsboro, Oregon, in 1913.

Hypoaspis armatus n. sp.

Male.—A uniform, light yellowish-brown color. Body oval, almost evenly rounded behind. Epistome long and ending in two prominent spines or teeth. Cheliceræ very characteristically armed. At the tip of each there is a very prominent lateral, recurved, hook-like projection with a barb at its tip; below this is a sharp incurved hook, which crosses its mate from the opposite side; above is a reduced arm with a pectinate process dorsally and in front. Ventrally near the base of the armed part of the chelicera is a simple tubercle. Peritreme very slender, curved similar to the margin of the body next to which it lies. Abdomen clothed above with a few moderate, slightly pectinate setæ; the shoulder pair is especially prominent. At the anterior end of the abdomen near the median line is a pair of medium, simple setæ. Legs long; tarsus of leg I about one and a half times as long as the tibia and bearing a pair of weak claws at the tip of a very long pedicel; tibia of leg I fully twice as long as broad and broader distally than proximally; last pair of legs extending beyond the tip of abdomen. Length, 0.27 mm.; width, 0.17 mm.

From Whittier, California; on lemon leaves; by Mr. Neüls. The type specimen from Neüls shows the sperm sac attached to the tip of the cheliceræ. In the *Gamasidœ*, the male transfers the sperm from his genital orifice to the vulva of the female in a hyaline sac by means of the cheliceræ. The various modifications of the chelicerae are frequently adaptations for this method of fertilization.

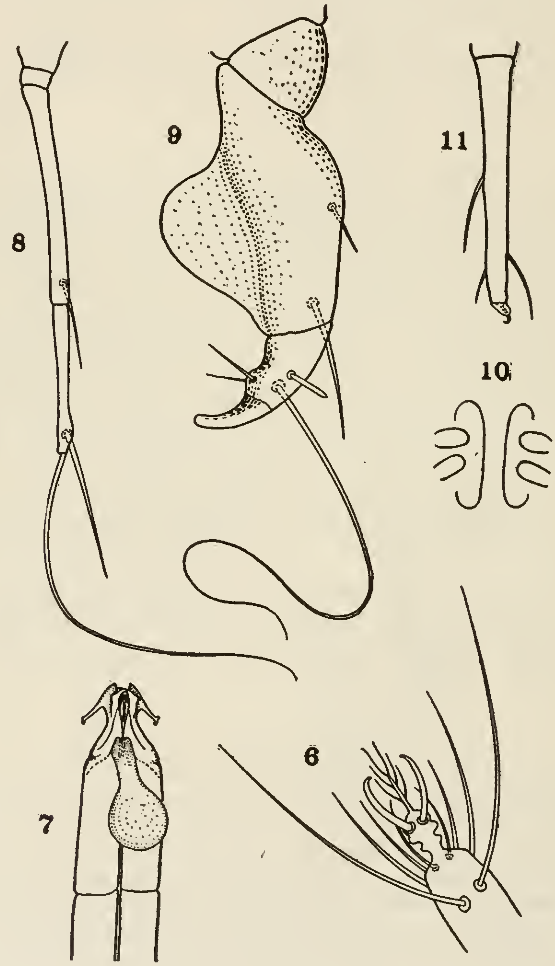


Fig. 26. 6, *Caligonus mali* n. sp. Tip of tarsus of leg I from above; 7, *Hypoaspis armatus* n. sp. Chelicerae of male from below, showing the sperm sac adhering to the hooks near the tip; 8, *Tarsonemus pallidus* Banks (?) Left hind leg of female from below; 9, *Tarsonemus pallidus* Banks (?) Right hind leg of male, from above; 10, *Monieziella bipunctata* n. sp. Vulva; 11, *Monieziella bipunctata* n. sp. Tarsus of leg IV.

Tarsonemus pallidus Banks (?)

Female.—Body pale yellowish-brown, capitulum darker. Total length of the body about twice that of its greatest width. Capitulum large, extending forward to about the middle of tarsus of leg I. Pseudostigmatic, or sense, organs dorso-lateral, with spherical heads and very short pedicels, which arise from prominent circular pores. Just lateral to each sense organ is situated a very long tactile seta, which surpasses by fully a third of its length leg II, near which it is also situated. Abdomen more or less pointed posteriorly, and bearing along its posterior margin three pairs of small, inconspicuous setæ. Anterior pair of legs stout; second pair slightly smaller; third pair extending beyond the margin of abdomen by the full length of the tarsus and one-half the length of the tibia. Posterior legs reaching the tip of abdomen; tarsus almost two-thirds as long as the tibia, and bearing at its tip a very long terminal seta, as long as the total length of leg IV; a short distance from its tip, on the outside, the tarsus bears a somewhat stouter seta, a little over a third as long as the terminal one. Length, 0.21 mm.; width, 0.12 mm.

Male.—Body stout, legs short. Capitulum reaching the tips of anterior legs. Lateral spine at junction of cephalothorax with abdomen about one-half as long as leg II. Leg IV very characteristic, segment II about two-thirds as long as the entire leg, curved, with a large, hyaline, blade-like expansion on the inside which is almost as broad as the segment proper and extends for about the distal two-thirds of the segment; below near its tip segment II bears a long seta. Segment III of leg IV short, much curved, bearing below near its tip a very long seta, which is equal in length to the entire leg; on the outside there is a short seta, and a more or less spine-like one on the inside at the tip. Distal claw long, curved, but tip not sharpened. Length, 0.13 mm. width, 0.09 mm.

From Corvallis, Oregon; on cyclamen; by G. F. Moznette. Described from several specimens. According to Mr. Moznette this species causes serious injury to the cyclamen plant.

Monieziella bipunctata n. sp.

Alcoholic specimens pale yellowish, with the lateral abdominal maculations a chestnut brown. Cheliceræ large, stout. Cephalothorax more or less triangular in shape; anterior bristles prominent, slightly surpassing the mandibles; posterior bristles equal to about one-half the total length of the body, and each situated about one-half the distance from the median line to the lateral margin of the body. Abdomen separated from the cephalothorax by a transverse almost straight line. Shoulder bristles small, inconspicuous. At its tip the abdomen bears a pair of very long setæ. They are about as long as the width of the abdomen itself. Legs moderate; anterior pair extending beyond the tips of the cheliceræ by about a third of their length. Tarsus of leg I about twice as long as the tibia with a rather stout seta above about one-third the length of the segment from its base, a slender tactile seta above near tip, and a rather long seta ventrally near the base. Length, 0.22 mm.; width, 0.12 mm.

From Oregon; on base of buds of filbert; by A. L. Lovett. Many specimens.

Scientific Notes

Apple and Thorn Skeletonizer (Hemerophila Pariana Clerck). This insect, kindly determined by Karl Heinrich through the courtesy of Doctor Howard, has become well established in Irvington, N. Y., ranging east to White Plains, south to Scarsdale, and is reported as being present for a mile or two on the west bank of the Hudson. The caterpillars skeletonize the upper surface of the leaf, usually drawing in a variable strip on each side about half an inch wide and spinning a light web near the center of the leaf. Portions on each side of the base of the leaves are frequently untouched, though in serious infestations every leaf may be entirely skeletonized and this is true of whole orchards as well as of infested trees. The work of this insect may be distinguished from that of the fall web worm by the absence of the enveloping web inclosing one or more leaves. Furthermore, the full grown caterpillars are only about half an inch long, yellowish, black-spotted, sparsely haired and with the active movements of the Tortricid.

The pest was first brought to our attention by Mr. B. D. Van Buren of the Department of Agriculture and the first American notice was in the *Digest* for the week ending August 16, 1917, issued by the Insect Pest Survey and Information Service of the New York State Food Supply Commission. Subsequent observations show that various sized caterpillars may be found upon the leaves the last of September. It is recorded by Meyrick as local on apple and hawthorn, the moths hibernating and the larvæ being found in May, June and August.

The caterpillars are easily destroyed with poison and, since they feed upon the upper surface of the leaf, it should be impossible for this insect to become abundant in well sprayed orchards.

E. P. Felt.

The Collection of Hemiptera in the United States National Museum. It should be of interest to all American workers in Hemiptera as well as to workers in other orders to know something in regard to what is without doubt the largest collection of Hemiptera in North America. Since the death of the late Otto Heidemann, who was for ten years Custodian of Hemiptera in the United States National Museum, the entire collection has been rearranged.

All specimens are now kept in cork-lined drawers with glass covers, and these in steel cabinets.

The collection of Hemiptera in the Museum includes all of Heteroptera and Homoptera exclusive of Aphididæ, Aleurodidæ and Coccidæ. It has been built up of material sent in from numerous economic workers of the Bureau of Entomology and state departments, by generous donations of specimens from individual workers and students, and also by trades and purchases. The Fitch, Ashmead, Coquillett, and Uhler collections have been notable acquisitions, and it is hoped that in the future the generous spirit which has been the means of building up the best collection of Hemiptera in North America will continue to prompt entomologists to donate specimens freely so that in a short time we may be proud to be able to claim the best in the world.

At the present time there are approximately 150,000 specimens in the collection. Of this 60,000 have been determined. The Nearctic region is represented by 107,000 specimens; the Neotropical by 20,000; the Palæarctic by 10,000; the Ethiopian by 7,000; the Oriental by 3,000; and the Australian by 3,000. The average number of duplicates in a species is 10. There are 600 series of types, cotypes, or paratypes, exclusive of many in the Uhler collection which have never been designated.

Besides the above, the C. F. Baker collection with approximately 30,000 specimens is on deposit and available for study.

During the past six months over 60 series of specimens, many including 25 or more species, from collectors and economic workers, have been determined. This work will be continued zealously and determinations made and returned as quickly as is consistent with accuracy.

Edmund H. Gibson,
In Monthly Letter of the Bureau of Entomology.

Notes on Tarsonemus pallidus Banks (Acarina).[1] The pest, *Tarsonemus pallidus* Banks, although common in greenhouses on such plants as geranium, cyclamen, snap-dragon, etc., has not been studied sufficiently to afford life-history data upon which to base control measures.

The mite lays eggs on the under surface of the leaves either singly or in groups. The eggs hatch in 3 to 7 days at a temperature of 25°C. and the larva which is minute and pearly white passes through two stages, an active and a quiescent period. The active period averages 2.2 days and the quiescent, 1.7 days, the temperature ranging between 20 and 25°C. The skin is moulted at the end of the quiescent period and the adult mite emerges. The total length of the life cycle from egg to adult averages 9.1 days. The adults begin to lay within two days after emergence and the eggs whether fertilized or not produce normal larvæ usually of the female sex. The insect is parthenogenetic and continuous generations of isolated females have been kept for 5 months without the intervention of the male. The eggs are laid at the rate of 1 or 2 per day and adults kept in confinement sometimes live as long as 17 days. The total egg-laying capacity is from 12 to 17 eggs per female. Fertilization apparently takes place while the female is still quiescent, but copulation has also been seen to take place between adults of both sexes. The ratio of males to females under normal conditions is about 1 to 8.

Experiments indicate that in winter little trouble should be experienced from the attacks of the mite if plants are kept well spaced and reasonably dry. In summer it is best to syringe daily until control is obtained with a stream of not less than fifty pounds pressure. The mites are more easily dislodged than the red-spider and control methods offered for the latter mite by Ewing[2] are therefore effective in combating the Tarsonemus mite.

The writer suggests the name "pallid mite"[3] as a common name rather than "cyclamen mite" as used by Moznette,[4] because of the fact that it occurs on other plants as well as cyclamen and often causes as much or more injury than to cyclamen.

Philip Garman.

The Reddish-brown Plum Aphis in New York State. In reference to the paper by W. M. Davidson on p. 350, vol. 10, of the Journal, the following information may be of interest. In 1897, Lintner, 13th Rept., p. 363, recorded the presence of a species infesting the plum. Specimens were sent to Washington and were studied by Mr. Pergande, but were not determined specifically. Pergande's note is as follows: "June 21, 1897. Received from J. A. Lintner, Albany, N. Y., a few specimens of a *Rhopalosiphum* found at East Greenbush, Rensselaer Co., opposite Albany, on a

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[1] Contribution from the Entomological Department, Maryland Agricultural Experiment Station.

[2] Ewing, H. E. Oregon Agr. College Exp. Station. Bul. 121: 87, 1914.

[3] Garman, P. Maryland Agr. Exp. Station. Bul. 208, 1917.

[4] Moznette, G. F. Jour. Econ. Ent. 10: 344, 1917.

plum tree, infesting largely the fruit." A short color description then follows. These specimens are in the collection of the Bureau of Entomology and prove to be spring migrants of *nympheæ*. This is possibly the earliest American record of the plum-feeding habit of the species.

The foregoing information was submitted to Mr. Davidson, but he preferred to confine his remarks to western material.

Recently we have received specimens from Mr. W. F. Turner, Thomasville, Ga., which add another state to the distribution records.

A. C. Baker, *Washington, D. C.*

Scientific Note on Beetles Causing Damage to Cotton in Yuma Valley, Arizona. In answer to a communication from Dr. A. W. Morrill the writer visited fields in the Yuma Valley of Arizona where severe injury to seedling cotton was reported. Interviews with leading planters and examination of affected fields brought to light the fact that about 500 acres had been replanted twice following as many complete destructions of the seedling fields. The attempts to secure a stand were finally abandoned, and milo was planted. Careful examinations in these fields revealed the presence in millions of a dirt-colored beetle $^3/_{16}$-inch long, which has been determined by Mr. E. A. Schwarz as *Myochrous longulus* Lec.

In the affected fields not a trace of cotton was to be seen above ground. Search in the soil of the bed rows revealed the presence in great numbers of the above species. The adults were seen in many cases still in place on the underground portion of the stems of the decapitated seedlings, but were also seen commonly feeding on the subterranean, succulent stems of arrowweed, trailing-mallow and *Baccharis* sp.

All affected fields were in crop for the first time, and, prior to clearing, the land had (last season) supported an almost pure growth of arrowweed (*Pluchea sericea*). Owing to the ease with which the Myochrous beetles were found on the arrowweed stems it would appear probable that this is the native host of the pest. It is reasonable to suppose, then, that following the eradication of the arrowweed the beetles transferred their attentions to the young, tender cotton plants which were readily at hand.

E. A. McGregor.

A Second Importation of the European Egg-Parasite of the Elm Leaf-Beetle. In the Journal of Economic Entomology, vol. I, No. 5, 1908, pages 281–289, I gave an account of the importation of *Tetrastichus xanthomelænæ* into this country through the help of the late Professor Valery Mayet, of Montpellier, France, and of its apparent establishment in The Harvard Yard and at Melrose Highlands, Massachusetts, and of its attempted colonization by the late Dr. John B. Smith at New Brunswick and the late M. V. Slingerland of Ithaca and upon elm trees in Washington near Dupont Circle. Since the publication of this article, this species has not been recovered in the United States. The death of Professor Valery Mayet and the scarcity of the elm leaf-beetle in the south of France for several years, and later the oncoming of the great war, have prevented other attempts to introduce and establish this active parasite.

On the 25th of June of the present year, however, I received from Prof. F. Picard, of the École Nationale d'Agriculture, Montpellier, a cigar-box full of elm leaves bearing parasitized eggs of *Galerucella luteola*. I turned the material over to Mr. J. Kotinsky of the Bureau of Entomology, and telegraphed to Prof. J. G. Sanders, Dr. T. J. Headlee, and to the Entomological Department of Cornell University for information as to the prospects of colonization. The season was already late, and the para-

sites were coming out on arrival. Moreover, the box was not tight. On the day following the arrival of the sending, Mr. Kotinsky brought together thirty adults which were active and mated freely. Elm leaves daubed with honey were supplied to them for nourishment, but they gave little attention to it. No elm leaf-beetles were found in Washington, and Mr. Kotinsky, on receipt of a telegram from Mr. Sanders to try Philadelphia, bottled the colony and took it to that city. With Mr. F. M. Trimble, one of Mr. Sanders' assistants, a search for the elm leaf-beetle was first made in Logan Square opposite the Philadelphia Academy of Natural Sciences, where they were accompanied by Dr. Henry Skinner, and later in Fairmont Park, but to no avail. Finally eggs of the elm leaf-beetle were located near the Andorra Nurseries, City Line, Chestnut Hill, Philadelphia, and most of the parasites were released on the south side of Barren Hill Road, middle tree (eighth from either end), between the first and second road entrances to the nursery grounds. Eggs confined with the insects in a vial prior to their release did not seem to attract them.

In the meantime, Prof. Robert Matheson, of Cornell, had notified the writer that some eggs were still unhatched at Ithaca, and, on orders from the Washington office Mr. Kotinsky mailed the remaining parasites to Ithaca.

On Mr. Kotinsky's return to Washington, a few more parasites were found to have issued, and eventually these were released, on the 19th of July, on an elm tree in the back yard of 1914 Sixteenth Street, where fresh elm leaf-beetle eggs were found.

Professor Picard promises another sending in 1918, and the writer will be glad if entomologists interested will notify him of their wish to attempt the colonization in regions of elm leaf-beetle abundance next June.

L. O. Howard.

THIRTIETH ANNUAL MEETING, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS, PITTSBURGH, PA., DECEMBER 31, 1917 TO JANUARY 2, 1918.

The Thirtieth annual meeting of this Association will be held at Pittsburgh, Pa., on the dates above mentioned. Sessions will also be held for the section on Apiculture and the section on Horticultural Inspection.

The exact hours of holding the sessions of this Association and its sections, together with the program, will be published in the December number of the Journal of Economic Entomology. It is planned to devote one session to a symposium on some important phase of insect investigations.

In order for papers to be included in the program, it will be necessary for the titles to be filed with the Secretary on or before *November 10.* Papers should be prepared so that they can be presented in not to exceed fifteen minutes; and it is suggested that if the subject which is covered will require a longer time, that an abstract be read.

Titles of papers to be presented before the section on Apiculture should be forwarded to the Secretary of that section, Mr. N. E. Shaw, Secretary of Agriculture, Columbus, Ohio. Titles on Horticultural Inspection should be forwarded to the section on Horticultural Inspection, Prof. J. G. Sanders, Economic Zoölogist, Harrisburg, Pa.

Entomologists desiring to become members of the Association can secure the necessary blanks from the Secretary or from Prof. J. G. Sanders, Harrisburg, Pa., who is the Chairman of the membership committee.

Prof. R. A. Cooley, *President,*
Bozeman, Mont.

A. F. Burgess, *Secretary,*
Melrose Highlands, Mass.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1917

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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Crop production and food conservation have received much attention this season and will be given more another year. The large appropriations ($145,775 allotted to the Bureau of Entomology) just made for this work by the federal government are none too great for the country as a whole, especially when we remember that it is impossible to wage a successful contest on an inadequate food supply. The practical side of entomology never has had a better chance to demonstrate its utility and more will be demanded along this line another year. It should not be forgotten that we are dealing with living organisms and while prognosis is possible to some extent, much can not be foreseen. The organization which wins will be a flexible one, planned upon comprehensive lines and adapted to rapid changes. The probable should be anticipated, the improbable guarded against and the work at all times be upon a practical basis.

The above considerations compel the limiting of major activities to the control of the more important pests along lines of demonstrated utility. The shortage of help is favorable to the increased use of machinery and it is quite possible that in some localities wholesale spraying on a scale hitherto considered impractical would be entirely feasible. The problem is to secure the greatest possible protection from insect depredations with a minimum expenditure of effort. This suggests the practicability of high power spraying outfits manned by trained crews in sections where there is great need for spraying. Insecticides are of little value without spraying machinery. The next

few months should be devoted to learning the needs for both and making plans to secure the effective distribution of machinery and insecticides. One is well nigh useless without the other. This distribution must be followed by effective operation or the work counts for little.

Data at hand should be made available to indicate the safest rotations or desirable modifications in cropping in order to prevent insect injury. Every entomologist knows the risk incurred by planting corn or potatoes on land badly infested by young white grubs, the sowing of wheat early enough to permit infestation by Hessian fly, etc. Such precautions involve little or no additional labor. Self-interest, if not concern for the national welfare, should and probably will lead most farmers to observe these common-sense precautions and it is for the economic entomologist to see that he can not plead ignorance of the matter—it would be even better if growers had the stimulus of nearby demonstrations.

Reviews

School Entomology, An Elementary Textbook of Entomology for Secondary Schools and Agricultural Short Courses, by E. Dwight Sanderson and L. M. Peairs. John Wiley & Sons, New York, 1917. Pp. 356, figs. 233. Price, $1.50.

We have in this work an excellent discussion of the systematic and economic phases of entomology admirably adapted to the needs of agricultural and secondary students in particular. There is enough of structure and taxonomy to give the student a good idea of insect life and yet this aspect is not allowed to obscure the more practical part II. It has been said, and truly, that all entomology is economic and yet there are some works on economic entomology that run largely to the systematic and vice versa. This book is admirably proportioned. The keys are sufficient for considerable taxonomic work. The student will find material assistance in the series of illustrations showing types of the more important groups of insects. The economic part is limited to discussions of the more destructive pests. The value of the book is greatly increased by the short list of the more important recent contributions to insect literature, thus making further study easy. The authors have produced a very meritorious work which will be greatly appreciated by teachers and students. (*Advt.*)

Current Notes

Conducted by the Associate Editor

Mr. S. B. Doten is secretary of the Nevada State Committee on Food Resources.

Mr. A. O. Larson, B. S., has been appointed assistant entomologist at the Utah Station.

Mr. W. A. Keleher, for many years a valued employee of the Bureau of Entomology, died early in August.

Mr. Frank H. Lathrop has been appointed research assistant in entomology at the Oregon College and Station.

Mr. H. R. Hagan has been appointed assistant professor of zoölogy and entomology at the Utah College and Station.

Mr. F. M. Wadley, Bureau of Entomology, will be in charge of the Field Station at Wichita, Kans., vice F. B. Milliken.

Dr. J. Chester Bradley of Cornell University will spend next year as assistant professor of entomology at the University of California.

Mr. A. P. Sturtevant, Bureau of Entomology, recently made a trip in New Jersey and Massachusetts studying European foulbrood conditions.

Mr. H. L. Weatherby, Bureau of Entomology, will be in temporary charge of the station at Rocky Ford, Colo., formerly in charge of Mr. Marsh.

Dr. E. F. Phillips, Bureau of Entomology, went to Denver, Colo., the last of July to attend a meeting of beekeepers of Colorado and adjacent states.

Mr. August Busck, Bureau of Entomology, left Washington on August 20 for an extended trip through northern Mexico, to study the pink bollworm.

Professor H. A. Morgan, director of the Agricultural Experiment Station, Knoxville, Tenn., has recently been appointed Federal food administrator for the State of Tennessee.

Mr. H. E. Shaw, formerly Chief of the Bureau of Horticulture, Ohio State Department of Agriculture, has recently been appointed Secretary of Agriculture for the State of Ohio.

Mr. J. S. Houser, Associate Entomologist of the Ohio Station, served for two or three months as District Food Commissioner of two Ohio counties, returning to his work at the Station July 1.

Mr. Morley Pettit, of the Ontario Agricultural College, Guelph, has resigned as Provincial Apiarist, and after November 1, 1917, will devote his attention to The Pettit Apiaries, with headquarters at Georgetown, Ont.

Mr. George F. Moznette, assistant in entomology at the Oregon College and Station, has resigned to accept a position as entomological inspector of the Federal Horticultural Board and assigned to duty at Washington, D. C.

Dr. D. W. Pierce, Bureau of Entomology, made a general trip in July through the South, visiting the laboratories at Madison, Fl., Mound, La., Clarksville, Tenn., Dallas, Texas, Uvalde, Texas, and El Centro, Calif.

Mr. F. E. Brooks, Bureau of Entomology, in charge of the laboratory at French Creek, W. Va., visited Michigan and Wisconsin during the latter part of June in connection with his studies of apple-tree and other borers.

Mr. D. M. Rogers, in charge of gipsy moth quarantine and inspection work, Bureau of Entomology, has moved his office from No. 43 Tremont Street, Boston, Mass., to the Boston Custom House, effective September 1, 1917.

Messrs. T. L. Guyton, J. R. Stear and P. R. Lowry, all entomological students from the Ohio State University, were employed during the summer months by the entomological department of the Ohio Station at Wooster.

Mr. G. S. DeMuth, Bureau of Entomology, went to Blacksburg, Va., August 16 to attend a meeting of beekeepers held at that place during Farmers' Week. At this meeting the Virginia State Beekeepers' Association was organized.

During July and August Mr. V. L. Wildermuth, Bureau of Entomology, made an extended insect survey through the northern part of Arizona, being accompanied, for a portion of the time, by Dr. O. C. Bartlett, Assistant State Entomologist.

A bill will probably be considered by the Texas legislature now in special session providing for the establishment of a cotton-free zone to include the counties bordering on Mexico, such zone to be administered in coöperation with the Federal Horticultural Board.

Mr. Kenneth Hawkins, Bureau of Entomology, left Washington July 9 to attend state meetings of county agents in Oklahoma, Texas and other Southern States, and spent the latter part of August in Virginia, holding local meetings of beekeepers in coöperation with county agents.

Dr. D. W. Pierce, Bureau of Entomology, finds several species of European origin among our *Gymnœtron* and *Miarus* and therefore desires to receive for study material from all parts of the country. *Gymnœtron* breeds in the flowers of *Verbascum* and *Linaria*, and *Miarus* breeds in the flowers of *Lobelia*.

Recent visitors to the Bureau of Entomology include Professor K. W. Dammermann, Java; Professor H. Garman, Lexington, Ky.; Professors E. R. Scholl, F. B. Paddock, S. W. Bilsing, entomologists, and Mr. E. L. Ayers, Chief Nursery Inspector, Texas; H. G. Barber, Roselle Park, N. J.; Carl J. Drake, Syracuse, N. Y.

Mr. R. D. Whitmarsh, assistant entomologist of the Ohio Station, served as military instructor at the University of Wooster during the spring months, devoting four afternoons each week to this instruction. Mr. Whitmarsh has volunteered for the Second Officers' Training Camp at Fort Benjamin Harrison at Indianapolis, Ind.

Mr. Simon Marcovitch, assistant entomologist for the past three years at the University of Minnesota, has resigned his position to accept an offer as head of the Department of Biology at the National Farm School, Bucks County, Pennsylvania. Mr. Marcovitch expected to leave September 14 to take up his new duties in the East.

The following resignations from the Bureau of Entomology have been announced: Miss Myrtle Duckett, Bee Culture; B. L. Royden, Truck Crop Insect Investigations;

Pauline Margaret Johnson, Truck Crop Insect Investigations; F. H. Gates, Cereal and Forage Insect Investigations; H. L. Parker, Cereal and Forage Insect Investigations.

Dr. William M. Wheeler, of Harvard University, Dr. J. Chester Bradley of Cornell University, and Dr. C. L. Bequaert of the American Museum of Natural History, New York City, spent about a week in the vicinity of Tempe, Arizona, collecting insect material and were frequent visitors at the field laboratory maintained there by the Bureau of Entomology.

Mr. T. E. Snyder, Bureau of Entomology, returned to Washington on July 31 from a trip through the Southern, southwestern Pacific Coast and Rocky Mountain States. On this trip insects injurious to forest products were investigated. Special effort was made to collect termites and data on the biology and geographical distribution of our native species. Mr. Snyder left Washington on March 16.

During June and the early part of July, Dr. E. A. Back, Bureau of Entomology, made an extended trip through the Middle West and the South to familiarize himself with the methods of storing grain and with insects affecting warehouses, grain elevators and flour mills. The establishments of many large concerns were visited in Chicago, Minneapolis, Kansas City, Wichita, Galveston, New Orleans, and elsewhere.

Dr. C. H. T. Townsend, Bureau of Entomology, is on an extended trip in the southwest to determine the exact range of the *Thurberia* plant and the weevil which feeds upon it. Special attention will be paid to the possible occurrence of the plant and weevil in regions in which cotton is now planted or in which it may be planted some time in the future. Dr. Townsend started from Las Cruces in New Mexico early in July with a pack train and will explore the country as far as Globe, Ariz., before the end of the season.

F. C. Bishopp and E. W. Laake, Bureau of Entomology, have completed a general trip of inspection to the larger meat packing establishments in the United States. This work is in coöperation with the Bureau of Animal Industry and has relation to the control of the house-fly and other insects in establishments operating under federal supervision. Later Mr. Bishopp made a trip to the Pacific Northwest, returning to Dallas via Topaz, California, where Mr. Webb is engaged in the study of insects affecting the health of animals.

An insect menace of considerable interest to citrus growers, particularly those of Florida, is the spiny citrus "white fly," *Aleurocanthus woglumi*. This insect, probably originating in India, has obtained a strong foothold in Cuba during the last few years, and may easily reach Florida by means of fruits or plants imported from Cuba. Harold Morrison, who is now in Cuba, is making a thorough investigation of this insect in Cuba and adjacent islands to provide adequate information for necessary quarantine or regulatory action.

The following employees of the Bureau of Entomology and the Federal Horticultural Board are variously designated for the military and naval service of the government: John Monteith, Jr., H. L. Parker, G. D. Pylant, T. S. Wilson, P. B. Miles, B. R. Leech, F. P. Keen, A. C. Mason, R. L. Daily, T. R. Chamberlain, D. J. Caffrey, H. K. Laramore, J. J. Culver, G. N. Wolcott, G. W. Martin, Harry D. Whitlock, L. J. Hogg, Manuel Garcia, L. P. Rockwood, Frank R. Cole, E. J. Newcomer, J. C. Evendon, W. E. Dove, H. B. Greaves, C. F. Cork and R. H. Bush.

According to the *Experiment Station Record*, the staff of the Department of Entomology at the Kansas College and Station and Federal entomologists are being organized to control the Hessian fly in counties where it promises to injure the wheat crop in 1918. The early and thorough plowing under of wheat stubble, elimination of volunteer wheat in fields later, and planting after the fly-free date are the recommendations being made. These practices, however, are advisable in order to obtain maximum yields, regardless of Hessian fly infestation.

Mr. Harold Morrison, Bureau of Entomology, who recently made a trip of exploration to the Virgin Islands and the West Indies, has completed his work in the Virgin Islands and Porto Rico and is probably now in Santo Domingo. Some very interesting communications have been received from him in relation to this work and good deal of valuable material. Valuable material is also being received from the collaborators appointed in Central and South American countries in connection with the study of the fruit-flies and other insect pests of such countries.

Mr. Jacob Kotinsky, Bureau of Entomology, spent June 27 in Philadelphia where, with the assistance of F. M. Trimble of the Pennsylvania State Zoölogical Service and the Federal Horticultural Board, elm-leaf beetle, *Galerucella luteola* Mull., eggs were located and a colony of parasites received by Dr. Howard from M. F. Picard of the Êcole Nationale d'Agriculture, Montpelier, France, was released. Small colonies of this parasite were also released in Ithaca, N. Y., by Professor Robert Matheson and by Mr. Kotinsky in Washington, D. C. No prediction as to results can be made as yet.

Mr. H. F. Dietz, Bureau of Entomology, is now in New York investigating the fumigation of orchids. The experimental work conducted by Messrs. Sasscer and Dietz with orchids has demonstrated that orchids can be safely fumigated with one ounce of sodium cyanid in a 20-inch vacuum at an exposure of 40 minutes without injury, provided reasonably healthy plants are used; in fact, with healthy plants as strong a dose as four ounces of cyanid has been used under the same conditions without killing the plants. A month after treatment the plants so treated are making new growth, both roots and buds.

C. W. Howard, Associate Professor of Entomology and Parasitology, University of Minnesota, has accepted the position of Professor of Biology in Canton Christian College, Canton, China. Professor Howard will sail from San Francisco the middle of October, visiting the Hawaiian Islands, Manila and Japan enroute. Canton Christian College is the only institution of collegiate rank in South China. The rapid growth of the agricultural and medical departments has made necessary the organization of a department of biology. All communications should be addressed to Canton Christian College, Honglok, Canton, China.

The following transfers in the Bureau of Entomology have recently been announced: W. T. Emery, Charlottesville, Va., to Wellington, Kans.; G. A. Runner to Sandusky, Ohio; J. S. Wade, Wellington, Kans., to Washington, D. C.; Dwight Isely, North East, Pa., to Bentonville, Ark.; J. J. Culver, Fort Valley, Ga., to Monticello, Fla.; A. I. Fabis, Monticello, Fla., to Brownwood, Tex.; D. J. Caffrey, Tempe, Ariz., to Hagerstown, Md., in charge of the laboratory; J. A. Hyslop, formerly in charge of the Hagerstown, Md., field laboratory, to Bureau Extension work; G. W. Barber, Wellington, Kans., to Hagerstown, Md.; H. O. Marsh, Rocky Ford, Colo., to New Jersey (temporarily); F. B. Milliken and A. B. Duckett, formerly truck crop insect investigations, to stored product insect investigations.

An estimate has been prepared for the Urgent Deficiency Bill of this session, calling for an appropriation of $500,000 to still further safeguard the United States from the pink bollworm. A conference was held on July 17 on this work, participated in by representatives appointed by the Governor of Texas, namely, the Commissioner of Agriculture and Messrs. Ayers and Scholl, and by Mr. Paddock, representing the experiment station, and Mr. Ousley, temporarily acting as Assistant to the Secretary of Agriculture, representing the state at large and particularly the State Extension Service. There was also present a committee of planters, representing the Lower Rio Grande Valley. The work proposed under the appropriation requested is the establishment of a cotton-free zone in Texas along the Mexican border, the survey and stamping out of local points of infestation in Mexico near the Texas border, and general surveys of the infested district in the Laguna and elsewhere in Mexico to be the basis of determining the advisability of undertaking exterminative work against the pink bollworm in Mexico generally.

The following appointments to the Bureau of Entomology have been made recently: Robert B. McKeown, a graduate of the Colorado Agricultural College assigned to deciduous fruit insect investigations to be located in Texas; Warren D. Whitcomb, a graduate of the Massachusetts Agricultural College, deciduous fruit insect investigations, Northern States; William O. Ellis, Syracuse University, deciduous fruit insect investigations, Riverton, N. J.; Chester I. Bliss, field assistant, deciduous fruit insect investigations, Sandusky, Ohio; F. S. Chamberlin, southern field crop insect investigations, Quincy, Fla.; G. D. Pylant, southern field crop insect investigations, Madison, Fla.; George E. Quinter, southern field crop insect investigations, Clarksville, Tenn.; J. W. Bailey, cereal and forage insect investigations, Tempe, Ariz.; P. H. Hertzog, cereal and forage insect investigations, Carlisle, Pa.; Frederick W. Poos, cereal and forage insect investigations, Charlottesville, Va.; W. C. Cartwright, cereal and forage insect investigations, Knoxville, Tenn.; H. L. Dozier, a graduate of the University of South Carolina, cereal and forage insect investigations, Tempe, Ariz.; H. R. Shoemaker, truck crop insect investigations, Arlington, Va.

Zoölogical Record: a correction. In the May 1917 *Monthly Letter* of the Bureau of Entomology a note appeared saying the *Zoölogical Record*, London, had temporarily suspended publication. This word was received by the Smithsonian Institution through its London agents. We are glad to learn now through a letter to Dr. Howard, under date of May 21, from Mr. P. Chalmers Mitchell, Secretary of the Zoölogical Society of London, that this is a mistake. The 1915 volume of the *Record* will appear soon and the 1916 volume is in preparation. The Society has no intention of letting the *Record* be suspended.

MABEL COLCORD,
Librarian, Bureau of Entomology.

Mailed October 20, 1917.

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OF

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MANUSCRIPT for publication should be sent to the Editor, E. PORTER FELT, Nassau, Rens. Co., N. Y.

CURRENT NOTES AND NEWS should be sent to the Associate Editor, W. E BRITTON, Agricultural Experiment Station, New Haven, Conn.

SUBSCRIPTIONS AND ADVERTISEMENTS may be sent to the Business Manager, A. F. BURGESS, Melrose Highlands, Mass.

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CONTENTS

THIRTIETH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Pittsburgh, Pennsylvania, December 31, 1917, to January 1 and 2, 1918

The thirtieth annual meeting of the American Association of Economic Entomologists will be held in the Assembly Room, Margaret Morrison Carnegie School, beginning December 31, 1917, and ending January 2, 1918.

Sessions will open at 10.00 a. m., Monday, December 31. The annual reports and reports of committees will be presented at that time and the annual address of the President will follow. The meeting of the general association will be continued at 1.30 p. m., Monday, December 31, at 10.00 a. m., Tuesday, January 1, and at 10.00 a. m. and 1.30 p. m., Wednesday, January 2. The final business will be transacted at the Wednesday afternoon session.

Sectional Meetings

The meeting of the section on Apiculture will be held at 8.00 p. m., Monday, December 31, at which the regular business of the section will be transacted and a program of papers presented. The sessions of the section on Horticultural Inspection will be held at 1.30 and 8.00 p. m., Tuesday, January 1. At the evening session, moving pictures will be exhibited showing the different phases of the gipsy moth work which is being carried on by the United States Bureau of Entomology in New England.

Other Meetings

The American Association for the Advancement of Science will meet December 28 to January 2. The Entomological Society of America will hold its annual meeting on Friday and Saturday, December 28 and 29. The annual address will be delivered by Prof. Vernon Kellogg, Saturday evening, December 29.

Hotel Headquarters

Hotel headquarters for this Association have been secured at the William Penn Hotel, where a minimum rate of $2.50 per day, on the European plan, has been secured. Members are urgently requested to secure reservation of rooms in advance, as the hotel facilities in

Pittsburgh will be severely taxed in order to accommodate visitors who are attending the convention.

Railroad Rates

Information concerning railroad rates to the convention should be secured from the permanent secretary of the American Association for the Advancement of Science. This information can be obtained by addressing Dr. L. O. Howard, Permanent Secretary, Smithsonian Institution, Washington, D. C.

Official Buttons

Official buttons for members of the Association will be furnished to all those who have paid dues for 1918. Applications for buttons should be made to the secretary at the time of the meeting.

Membership

Application blanks for membership can be secured from the secretary, or from members of the committee on membership, and all applications should be made out, properly endorsed, and filed with the membership committee on or before January 1.

Program

Monday, December 31, 1917, 10.00 a. m.

Report of the Secretary.

Report of the executive committee, by President R. A. Cooley.

Report of the employment bureau, by W. E. Hinds, Auburn, Ala.

Report of the committee on nomenclature, by Herbert Osborn, Columbus, Ohio.

Report of the committee on entomological investigations, by H. T. Fernald, Amherst, Mass.

Report of the committee on index of economic entomology, by E. P. Felt, Albany, N. Y.

Report of the committee on entomological work at the U. S. National Museum, by J. J. Davis, of West Lafayette, Ind.

Appointment of committees.

Miscellaneous business.

New business.

Annual address of the President, R. A. Cooley, Bozeman, Mont.
" Economic Entomology in the Service of the Nation."

Reading of Papers

"The Pink Bollworm (*Gelechia gossypiella*) in Egpyt," by H. A. Ballou, Barbados, British West Indies. (15 minutes.)

"Taking Stock," by Walter C. O'Kane, Durham, N. H. (15 minutes.)

The results of an inquiry intended to discover where we stand in knowledge of efficient control of the most serious insect pests.

"The Relation of the Systematist to the Economic Entomologist," by Edmund H. Gibson, Washington, D. C. (5 minutes.)

"A Method of Graphically Illustrating the Dist ibution of Injury by an Insect Pest," by Frederick Z. Hartzell, Fredonia, N. Y. (12 minutes.) Lantern.

A study of the migration and spring feeding of *Haltica chalybea* with biometrical studies in distribution.

"Factors Influencing the Distribution of the Sugar Beet Root Louse," by Asa C. Maxson, Longmont, Colo. (10 minutes.)

Description of the methods used and a summary of the results of a survey covering about 100,000 acres of the beet-growing territory of northern Colorado for the purpose of ascertaining the effect of previous crops, presence of host trees and other factors on the distribution of this pest in the territory surveyed.

"Texas Aphid Notes," by F. B. Paddock, College Station, Tex. (15 minutes.)

Notes on collections and records to date with life-history notes on same species.

Adjournment.

Program

Monday, December 31, 1917, 1.30 p. m.

Discussion of the Presidential Address.

Reading of Papers

"Notes on Some Southwestern Buprestidæ," by H. E. Burke, Los Gatos, Calif (10 minutes.)

Notes on the biology and economic importance of several species, especially those injurious to mesquite wood and posts.

"The Life History of the Strawberry Leaf-Roller, *Ancylis comptana*," by R. L. Webster, Ames, Iowa. (10 minutes.)

"Some Experiments on the Adult and Eggs of the Peach Borer, *Sanninoidea exitiosa*, Say., and Other Notes," by Alvah Peterson, New Brunswick, N. J. (15 minutes.) Lantern.

Response of the female during oviposition to certain common insecticides and other chemicals and the influence of various sprays on the hatching of the egg. Notes on use of tree protectors.

"The Apple Ermine Moth in New York," by Percival J. Parrott, Geneva, N. Y. (7 minutes.) Lantern.

Importations in nursery stock from abroad and occurrence of species in bearing orchards.

"Seasonal Irregularities of the Codling Moth," by Leroy Childs, Hood River, Ore. (10 minutes.)

Four years' observations in the Hood River Valley, Oregon.

"Notes on Three Species of Apple Leaf-Hoppers," by Frank H. Lathrop, Corvallis, Ore. (10 minutes.)

Brief notes on *Empoasca mali*, *Empoasca unicolor*, *Empoasca rosæ* at Geneva, N. Y. Includes life histories, habits, and transmission of fire-blight.

"Notes on the Woolly Aphis," by George G. Becker, Fayetteville, Ark. (15 minutes.) Lantern.

On the interrelationships of the hosts elm, apple and Cratægus.

"Notes on the Life-History of *Laspyresia molesta* Busck," by Philip Garman, College Park, Md. (10 minutes.) Lantern.

Additional facts in the life-history of the newly introduced fruit pest are given, together with the results of recent spraying tests.

"Remarks on the Status of the Sweetened Poisoned Bait for Fruitflies in America," by Glenn W. Herrick, Ithaca, N. Y. (10 minutes.)

"The Calcium Arsenates and Their Efficiency as Insecticides," by A. L. Lovett, Corvallis, Ore. (8 minutes.)

Two types of pure calcium arsenate have been prepared, and their chemical, physical and insecticidal properties studied. Unsafe alone but efficient when used with an excess of CaO or with lime sulfur.

"The Influence of Molasses on the Adhesion of Arsenate of Lead," by Frederick Z. Hartzell, Fredonia, N. Y. (10 minutes.)

Preliminary report on a method of testing adhesion of sprays and especially the results when molasses is used as a bait.

"Spreaders for Arsenate Sprays," by A. L. Lovett, Corvallis, Ore. (12 minutes.)

A number of materials have been tested as spreaders for arsenates. An efficient spreader will materially decrease the amount of poison necessary and decidedly increase its effectiveness.

"A Study of the Toxicity of Kerosene," by William Moore, St. Paul, Minn. (10 minutes.)

Chemical composition and physical characteristics of different brands of kerosene, and influence on the death of the insects and liability to "burn" plants.

"Certain Principles Governing the Value of Ether Soluble Compounds as Contact Insecticides," by William Moore and S. A. Graham, St. Paul, Minn. (10 minutes.)

Manner of penetration into the insect body of various ether soluble chemicals and the chemical and physical properties influencing this penetration.

"Some Further Facts on Low Atmospheric Humidity as an Insecticide," by Thomas J. Headlee, New Brunswick, N. J. (15 minutes.) (To be read by title.)

"Insecticide Tests with *Diabrotica vittata*," by Neale F. Howard, Madison, Wis. (10 minutes.)

Results of cage tests with several stomach poisons during past two seasons at Madison, Wis.

"The Imported Cabbage Worm in Wisconsin," by H. F. Wilson and L. G. Gentner, Madison, Wis. (10 minutes.)

"Some Root Maggots," by O. A. Johannsen, Ithaca, N. Y. (10 minutes.)

"Poisoned Bait Experiments with the Onion Maggot," by Neale F. Howard, Madison, Wis. (10 minutes.)

Brief statement of results obtained in two seasons at Green Bay, Wis.

"Notes on the Biology of the Angoumois Grain Moth," by J. L. King, Harrisburg, Pa. (15 minutes.) Lantern.

Brief description of life cycle and egg laying habits of the first generation of moths which attack the grain in the field.

"Studies on the Life-Histories of Two Kansas Scarabæidæ," by William P. Hayes, Manhattan, Kan. (10 minutes.)

A report on the life histories of a species of Cyclocephala and a species of Anomala.

"An Emergence Response of *Trichogramma minutum* Riley to Light," by George N. Wolcott, Utica, N. Y. (10 minutes.)

Adults of the Hymenopteron, *Trichogramma minutum*, normally emerge from one to two hours after sunrise, but when kept in darkness, more than six times as many emerge in the first hour after being exposed to daylight, as emerge in the dark per hour of previous daylight in the same day.

Adjournment.

SECTION ON APICULTURE

B. N. Gates, *Chairman.* N. E. Shaw, *Secretary.*

Program

Monday, December 31, 8.00 p. m.

Address by the Chairman, B. N. Gates.

Reading of Papers and Discussions

"Important Factors in the Spread and Control of American Foul Brood," by E. D. Ball.

"Extension Methods in Apicultural Work," by G. H. Cale.

"An Unusual Disease of the Honey Bee," by Elmer G. Carr.

"Foul Brood Eradication Work in Texas," by F. B. Paddock.

"Missouri Beekeeping," by Leonard Haseman.

"Opportunities and Rewards in American Beekeeping," by E. R. Root.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Program

Tuesday, January 1, 10.00 a. m.

The session will be opened by a paper by E. P. Felt on "Insects and Camp Sanitation." At the conclusion, this subject will be opened for discussion. It is hoped that all the members will come prepared to express their views on this important matter.

"How Can the Entomologist Assist in Increasing Food Production?" Every past president of the Association, who is present, will be given not to exceed 5 minutes to discuss this important subject. A general discussion will then follow.

Adjournment.

SECTION OF HORTICULTURAL INSPECTION

G. M. Bentley, *Chairman.* J. G. Sanders, *Secretary.*

The Federal Horticultural Board and Committees of The American Association of Nurserymen, and of the Society of American Florists and Ornamental Horticulturists have been invited to attend the sessions.

Program

Tuesday, January 1, 1.30 p. m.

Address by the Chairman, G. M. Bentley.

"Devastation by Imported Plant Pests Shows the Need of Quarantine against Foreign Plant Introduction," by J. G. Sanders, Harrisburg, Pa.

Discussion.

Adjournment.

Program

Tuesday, January 1, 8.00 p. m.

Selection of officers.

"The Control of Imported Pests Recently Found in New Jersey," by H. B. Weiss, New Brunswick, N. J.

"The Work of the Missouri Inspection Service," by L. Haseman, Columbia, Mo.

Moving Pictures of Gipsy Moth Work in New England, Conducted by the U. S. Bureau of Entomology.

Adjournment.

Program

Wednesday, January 2, 10.00 a. m.

Reading of Papers

"Entomological Extension Work in Pennsylvania," by C. H. Hadley, State College, Pa. (15 minutes.) Lantern.

Discussion of the organization, scope, and general conditions characterizing the work in this state.

"Planning a State Extension Project in Entomology," by T. H. Parks, Manhattan, Kan. (15 minutes.)

Planning the work and working the plan.

"Municipal Control of the Spring Canker Worm," by S. J. Hunter, Lawrence, Kan. (15 minutes.) Lantern.

An account of the methods employed and the results obtained by the city commissioners of Lawrence, Kan., in checking a serious out-break of the spring canker worm.

"Notes on Fumigation of Orchids," by E. R. Sasscer and H. F. Dietz, Washington, D. C. (15 minutes.) Lantern.

Dealing primarily with the fumigation of orchids at the ports of entry under vacuum conditions,—also including a list of orchid insects.

"*Mira saltator* Lindm, as a Parasite of the Hessian Fly," by W. R. McConnell, Carlisle, Pa. (10 minutes.)

Notes on the life history of a parasite originally described from Russia but not recorded from this country.

"Grasshopper Observations, Experiments and Demonstrations in Arizona, During 1917," by A. W. Morrill, Phoenix, Ariz. (10 minutes.)

Report of observations on feeding habits and injuriousness of differential grasshopper and of experiments and demonstrations with poisoned baits against this and other species.

"A New Method of Combatting the Chinch-Bug," by W. P. Flint, Springfield, Ill. (10 minutes.)

Results of experiments conducted during the summer of 1917 using soluble poisons to kill chinch-bugs.

"Fluctuations of the Clover Aphis Epidemic in South Idaho," by A. C. Burrill, Moscow, Ida. (5 minutes.)

"Notes on the False Wireworm (Eleodes) with Special Reference to *Eleodes tricostata*," by James W. McColloch, Manhattan, Kan. (15 minutes.)

A review of the economic literature of the genus Eleodes and the life-history of *Eleodes tricostata*.

Adjournment.

Program

Wednesday, January 2, 1.30 p. m.

Reading of Papers

"Mosquitoes and the Control of Malarial Fever in Missouri," by L. Haseman, Columbia, Mo. (10 minutes.)

This project is just getting under way and the paper will discuss more in particular the field open and plans of procedure. It is hoped that it will call forth helpful suggestions from other workers on mosquitoes and malarial fever.

"Mosquitoes of Colorado," by T. D. A. Cockerell, Boulder, Colo. (10 minutes.)

A brief account of the work done this year toward a mosquito survey of Colorado. Discussion of the mosquito problem in relation to recuperation camps.

"Mosquito Flight as a Factor in the Problem of Control," by Thomas J. Headlee, New Brunswick, N. J. (15 minutes.) Lantern.

The flight of fresh as well as of salt marsh species determines the methods used in controlling them. Extensive flight of certain salt marsh species was demonstrated some years ago; considerable flights of certain malarial species have been recently shown; now the house mosquito and the fresh-water swamp species are known to migrate. The occasion for flight is probably a certain complex of climatic factors and other causes.

"Some Results of Two Years' Investigations of *Dermacentor venustus* Banks in Eastern Montana," by R. R. Parker, Bozeman, Mont. (15 minutes.) Lantern.

Dealing with new ecological data.

"Sodium Fluoride—A Specific for Biting Lice," by F. C. Bishopp and H. P. Wood, Dallas, Tex. (15 minutes.)

A discussion of the use of sodium fluoride against Mallophaga on livestock, poultry and birds.

"Control of Lice on Pigeons," by H. P. Wood, Dallas, Tex. (10 minutes.)

Deals with the control of the lice which infest pigeons.

"The Chigger-Mites Affecting Man and Domestic Animals," by H. E. Ewing, Ames, Ia. (10 minutes.)

The known species of chigger-mites reported from man and domestic animals considered from standpoints of synonomy, economy and biology.

"Missouri Scale Insects (Coccidæ) and Their Host Plants," by A. H. Hollinger, Columbia, Mo. (10 minutes.)

An economic discussion of Coccidæ and the degree of infestation of the host plants, together with a cross check list of the Coccidæ and the plant species in the form of a chart or table.

Final Business

Report of committee on auditing.

Report of committee on resolutions.

Report of committee on membership.

Report of other committees.

Nomination of Journal officers by advisory committee.

Report of committee on nominations.

Election of officers.

Miscellaneous business.

Fixing the time and place of next meeting.

Final adjournment.

R. A. Cooley, *President*,
Bozeman, Mont.

A. F. Burgess, *Secretary*,
Melrose Highlands, Mass

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INSECTS AFFECTING COFFEE IN PORTO RICO

By R. H. Van Zwaluwenburg, *Entomologist, Porto Rico Agricultural Experiment Station, Mayaguez, P. R.*

Coffee has been cultivated in the island of Porto Rico for some one hundred and fifty years. Previous to the coming of the Americans in 1898, it was the great crop of the island, but within the past fifteen years sugar has forged into first place. The coffee acreage in 1912 was over 168,000 acres; the annual export value (no figures on domestic consumption are available) of the crop for the last five years averaged about $7,000,000. Although coffee ranks second in importance only to sugar cane, little attention has been given to the insect pests affecting it.

In most cases it is extremely difficult to suggest practical means of control for coffee insects. The average plantation has from 700 to 1,000 trees per acre, and the net annual profit per tree averages from two to four cents. In addition, most of the plantations lie in the mountains, and the character of the coffee land is very broken.

The best results in Porto Rico are obtained with coffee grown under shade. Shade trees not only protect the plants from the direct sun, but also conserve the moisture during the dry winter months. The most popular trees for coffee shade are guava (*Inga vera*) and guamá (*I. laurina*). Although these trees often harbor the very destructive "hormiguilla," they also provide almost ideal conditions for the growth of beneficial fungi. For this reason scale insects are almost never of serious importance in coffee plantations.

The literature concerning insects of coffee in Porto Rico is meagre, consisting almost entirely of short notes appearing in various annual reports of the Porto Rico Agricultural Experiment Station subsequent

to 1904. The late Dr. C. W. Hooker began an extended study of coffee insects and this article is a summary of his results and of the writer's observations up to date.

Coffee Leaf Miner

The most generally distributed pest of coffee is the leaf-miner ("minador de la hoja"), *Leucoptera coffeella* Stain. This insect occurs throughout the world in almost every country in which coffee is grown, and was probably brought to Porto Rico when the first coffee plants were introduced. Coffee is the only known host of this insect.

The adult moth is a small, silvery white insect measuring about 2 mm. in length. It is a swift flier, hiding under leaves during the daytime and venturing forth only at night. The length of adult life varies from 1 to 4 days.

The silvery white, flat, oval egg measures about .3 mm. by .2 mm. and has a boat-shaped depression which includes the greater part of its upper surface. It is usually laid on the upper leaf surface and hatches in from 3 to 8 days (average for 107 eggs, 4.7 days). The larva mines the parenchymatous tissue and seriously reduces the functioning area of the leaf, especially when the main veins are crossed. The larval period varies from 7 to 15 days (average for 38 larvæ, 11.4 days). The fully grown larva emerges through a hole in the upper surface of the mine, and after wandering over the leaf a few hours, spins its cocoon, usually on the underside of the leaf. From 3 to 9 days are spent in the pupa (206 pupæ averaged 5.3 days).

Artificial control of the leaf miner has so far been impractical. Nicotine sulphate sprays were partially effective for the larvæ, but failed to kill the eggs. Fertilizing may be a means of remedying the damage done by the miner, for with a stimulation of leaf growth the percentage of leaf area, not functioning because of the miner, will be lowered, for a time at least. The expense of fertilizers in Porto Rico, together with the low market value of coffee, makes fertilizing here a doubtful proposition from an economic viewpoint.

Some varieties of coffee seem to be practically immune to miner injury due to the thickness of their leaves; among these are the Liberian coffee and several other species belonging to the same group. Their product is considered inferior in quality to the common Porto Rican coffee, which is the typical *Coffea arabica*.

There are two fairly effective Chalcids parasitic on the miner in its larval stages. These are *Zagrammosoma multilineata* Ash. and *Chrysocharis livida* Ash. The latter is the more abundant of the two and at times is responsible for at least 30 per cent mortality.

Coffee Leaf Weevil

A weevil ("vaquilla") belonging to the genus *Lachnopus* is of primary importance in many plantations. It is not known to occur at elevations less than 300 meters.

This weevil is most abundant during April and May. It is at this time that the adult does enormous damage by feeding not only upon the leaves, but also upon the blossom buds and the newly set berries which are to produce the crop. The life history study of this insect has so far been unsuccessful in the warm climate of the coast.

Field observations indicate that the weevil has a one-year life cycle. The eggs are laid in flat masses of fifty or more between two overlapped leaves; on hatching, the larvæ enter the ground where they feed on the roots. The greater damage is that caused by the adult. The weevils feed upon *Vitex divaricata* in addition to coffee. A Chalcid has been bred from what appeared to be the egg cluster of this insect. Jarring the trees and hand picking during the months of adult abundance have been recommended, but have not yet been tried on a large scale.

Coffee-Shade Ant

In some districts the most serious pest of coffee is the "hormiguilla," an ant which is primarily a pest of coffee-shade, but too often attacks the coffee trees also. This insect (*Myrmelachista ambigua* Forel subsp. *ramulorum* Wheeler) eats out irregular longitudinal tunnels in which it rears its brood and cultivates colonies of two species of soft scales. When the host tree is coffee, the guest scale is a *Pseudococcus;* in most of the trees shading the coffee the guest is a fleshy, pink scale, representing a new species of *Coccus*. In coffee the tunnels are made in the new growth; this not only lessens the vitality of the plant, but also weakens the branches so that many are broken when the pickers bend them over to gather the berries.

Numerous poisoned baits and sirups have been tried without success. The only method promising relief consists in felling and burning all infested growth, planting temporary shade such as banana, in which the ant will not colonize, and after several months replanting permanent shade trees. By this means a 75-acre area has to all appearances been kept entirely free from the ant for about seven years. This method is very expensive and is of doubtful permanent value, for the danger of reinfestation from without the cleared area is always present.

A small yellow, very vicious ant known as the "albayarde" (*Wasmannia auropunctata* Roger) is reported to occasionally kill and displace colonies of the "hormiguilla." However this ant's pugnacity is

so respected by the pickers that they refuse to enter areas in which the "albayarde" is established.

Minor Pests

Two scales are common on coffee: *Saissetia hemispherica* Targ. and *Howardia biclavis* Coms. The former is the more common. Parasitic fungi hold the scales in check, especially in the case of *S. hemispherica* which is heavily parasitized by *Cephalosporium lecanii* Zim.

Complaints have been received from some localities of a Cossid larva which bores in the main trunk or larger branches of the coffee tree, usually in the upper third. The adult moth has been tentatively determined as *Psychonoctua jamaicensis* Schs. by Dr. H. G. Dyar, who states that it may prove to be a distinct species. The presence of the borer is easily detected by a knotty formation in the old wood. This insect is most often found in old coffee at altitudes up to 1,500 feet. Pruning and burning invaded wood is usually recommended. There has never been a severe outbreak of this pest, to the writer's knowledge; only a few scattering trees at most are attacked.

Another borer occuring in coffee trees is *Apate francisca* Fab. This beetle has a wide variety of host plants in which it makes its longitudinal tunnels for the purpose of egg-laying. The larvæ can develop only in dead wood for they cannot survive the sap flow of living trees. A living coffee tree may have as many as thirteen adults working in its trunk, and still survive, unless broken over by wind. The adults can be killed with a piece of stiff wire.

The spittle insect, *Epicranion championi* Fowl., is fairly common; spittle masses around a berry-cluster often contain as many as six nymphs. Dr. Hooker noted an external Hymenopterous parasite in one instance, but was unable to rear it to the adult stage.

Ormenis pygmæa Fab. is common on the stems of coffee, and has in addition a considerable range of other hosts. It has never been known to injure coffee noticeably. The same statements will hold for the Jassid, *Tettigonia occatoria*.

A mealy-bug (provisionally determined as *Pseudococcus longispinus* Targ. by Dr. Hooker) is sometimes abundant in the berry clusters, concealing itself between the berries.

During the spring an aphid, *Toxoptera aurantii* Boyer (determined by Dr. Edith M. Patch) is extremely abundant on new sprouts of coffee, which it occasionally damages severely. Other hosts of this insect in Porto Rico are orange (which is commonly allowed to grow in a half-wild state amid the coffee) and "geo," an undetermined tree. Dr. Hooker bred an undetermined Chalcid from this insect. For two years the writer has witnessed almost complete control of the aphid

during the late spring in the mountain plantations, by the entomogenous fungus, *Acrostolagmus albus*.

With a few exceptions noted, all of the insects discussed in the above paragraphs were determined by specialists in the Bureau of Entomology.

In addition to the above, there are two species of Maybeetles which attack coffee in the larval stages. The descriptions of these beetles which are probably new and distinct species of Phyllophaga have been drawn up by Mr. E. G. Smyth of Rio Piedras, but have not as yet been published. The larvæ of these beetles are primarily pests of cane, but are also commonly reported as injurious to coffee, particularly to young seedling plants. Two Tachinids have been reared from Phyllophaga adults; one, *Cryptomeigenia aurifacies* Walton, is fairly common; the other, *Eutrixoides jonesii* Walton, is comparatively rare. No other enemies of adults or larvæ have been noted in coffee plantations.

A DEMONSTRATION IN MOSQUITO CONTROL

By C. W. Howard, *University of Minnesota*

Minnesota has always been famous for its mosquitos, and no less in the vicinity of the Twin Cities than in other parts. Screened windows and porches are an absolute necessity for comfort in the summer. Some time ago the president of the Minneapolis Real Estate Board was in New Jersey and in one of the small towns of that state noticed that there were no screens on the windows or porches. Inquiry revealed the fact that mosquitos had been eliminated from the town. He returned to Minneapolis and at once began to plan for an anti-mosquito campaign to be carried out under the supervision of the Real Estate Board until such time as the City Health Department could assume control. The writer was asked by the board to conduct the field work and carry out the campaign except in the matter of publicity and the raising of funds, the University of Minnesota loaning his services for the purpose.

We have no malaria or other mosquito-borne disease in Minnesota, although Anopheles, both *A. maculipennis* and *A. punctipennis*, are present, the latter in considerable numbers in some parts. The campaign was undertaken, therefore, entirely from the standpoint of reducing a troublesome pest.

There are five mosquitos common in the vicinity of the Twin Cities; *Aëdes canadensis, Aëdes sylvestris, Culex pipiens, Culex restuans,* and *Culex tarsalis.* Several other species occur such as *Mansonia per-*

turbans, but these five are the ones which must be mostly considered. Minneapolis is well provided with swamps, and small ponds, which are fast being filled or dredged out by the Park Board so as to be harmless from the mosquito standpoint, but there are many of these still present in the newer parts and in the outskirts of the city. Places which were formerly pot holes full of water are now dry, but dumping is allowed in order to fill them for building purposes. These dumps are full of receptacles which hold water throughout most of the summer and in the cooler months of spring and fall are a prolific source of mosquitos. Sewer catch basins are another matter for consideration, as well as rain barrels, for the women of Minneapolis insist on collecting rain water as the city water is too hard for hair washing.

It was felt that the first season's work must be in the nature of a demonstration if we were to gain support from the public for such a large undertaking as was ultimately contemplated. Accordingly, eight square miles of territory were tentatively chosen in the lake district of South Minneapolis in which conditions were typical for the city and of more than usual difficulty for mosquito control, also where the residents were of a class from which financial support could be obtained.

It would seem that it was an almost impossible task to isolate eight square miles in the center of a city and free it of mosquitos. The area was chosen with this in view. After the preliminary survey more territory was added to the original eight square miles in order to render the results surer, making a total of about ten square miles covered.

It was not possible to get the work inaugurated sufficiently early to catch the first spring brood of *Aëdes canadensis* and *sylvestris*, but the later broods were held in control.

The ten square miles were divided into six districts and an inspector placed in charge of each. A weekly inspection of every yard and premise in the district was made. The season was of such a nature that four sprayings of the swamps were sufficient, the inspectors being taken from their other work and assigned to this work at the proper intervals. The City Park Board agreed to spray all swamps on their property, as did the Great Northern Railway and Lakewood Cemetery which is situated on the southern boundary of the district. The cemetery superintendent also saw to it that all flower vases were emptied once each week. After the first spraying the Park Board ran short of funds and turned the work back to the Real Estate Board. This made our work very heavy for six men, for the swamps in the Lake District are very extensive, one, the remains of an old tamarack swamp, requiring three men a week to cover adequately with oil.

The City Health Board gave their support to the work by granting official badges to the inspectors, so that they were able to enter private premises unmolested. A total of nine inspections were made between June first and September first. With approximately 16,673 premises in the territory covered, this gave a total of 150,000 visits made by the six inspectors. Over 775 rain barrels were found, in spite of the presence of the city water supply, all holding water and breeding mosquitos. Over 335 dumping places were found, one of them, the remains of an old gully, extending nearly three miles across the city. It required some extra labor to keep these dumps mosquito-less, by smashing or burying water collectors. Sewer catch basins numbered 4,272, about 20 per cent of which were defective and mosquito breeders. Each city block averaged about twenty uncovered barrels or ash tins holding tin cans, which were potential mosquito nurseries. From this data it can be seen that the work of the inspectors was not light. Even the dry period coming in late July and August gave no respite, for every small collection of water was found by the mosquitos and the intense heat hastened their development.

In the spraying small D. & B. No. 2 compressed air spray pumps were used, these pumps enabling the operator to control the pressure without removing the tank from his back. We were unable to secure the grade of oil desired, so employed a mixture of heavy fuel oil and kerosene, which gave good results.

In addition to field supervision a biweekly meeting of inspectors was held at which difficulties encountered and plans for the work were talked over. Frequent shifts of inspectors to new districts enabled us to check up on the inspection and make it more thorough.

A leaflet on mosquitos was prepared and printed by the Real Estate Board. A copy was left at every house in the territory and was given to every school child in the city.

Active work was begun on June 1, and by July 1 results began to be very evident in most parts of the eight square miles, and by August 1 few mosquitos were left. We had prophesied that the work would reduce mosquitos 95 per cent, but 99 per cent was a closer approach to the actual reduction. The following letter, printed in the *Minneapolis Daily News* on July 26, is a sample of the opinion which the public passed upon the work.

"*Editor, Daily News.*—When we first moved into our present home, three blocks from the Lake of the Isles, the mosquitos were so bad that we could not weed our gardens in the early evening or sit out with comfort. We actually had to sacrifice our gardening after several seasons of battling with the skeets and we had to screen our porches

at considerable expense or we could not have used them at any time after 6 p. m.

"This summer we have a fine garden and it is a pleasure to work in it because the mosquitos are practically gone. Last evening we sat out on our lawn from 7 to 10 p. m., and in all that time only one lonesome mosquito showed up. We have had our suppers out in our back yard during this hot weather and feel that at last we are getting 100 per cent use of our home investment."

Many citizens remarked to the writer and to the inspectors that for the first time since they had lived in Minneapolis were they able to spend their evenings on lawns and porches without screens and in comfort. Visitors to the Lake Harriet pavilion, close to an area of large mosquito swamps, were able to enjoy the evening concerts with very much less annoyance than usual from mosquitos, although the pavilion was on the extreme limit of our district. Those who indulged in canoeing on Lake of the Isles and Cedar Lake in the evening were also free from the usual pest of mosquitos. One of the best results of the work this past season was the greater attention given to sanitary conditions by the people of South Minneapolis.

As a demonstration of what can be done in the control of mosquitos under city conditions, the campaign was a marked success. It demonstrated what can be done, when the work has been well planned and carefully carried out by good inspectors. Before the summer was very far advanced it was evident that we had chosen one of the most difficult parts of the city in which to carry out the work. The success under such conditions, therefore, shows what could be done over the entire city. A preliminary survey of the city also confirms the opinion that the entire city can be made practically free of mosquitos at small cost, and in addition the reduction of house-flies can be undertaken by the same staff of inspectors. In the eight square miles covered by the inspectors this year, there were found 574 stables, each one with a fly-breeding manure pile, as well as 353 out-door toilets, every one in an unsanitary condition, and a possible source of fly-borne infection.

With both flies and mosquitos under control many sources of disease would be eliminated, not to mention the fact that expensive screens on windows, doors and porches would be no longer needed.

Work ended September 1 as funds were getting short and the demonstration had given sufficiently convincing results.

The City Health Department has tentatively promised to lend financial as well as moral support the coming year. With a large staff and with house-fly elimination added, the brigade of inspectors will become an important adjunct to the City Health Department.

The Real Estate Board undertook the raising of finances for the work by public subscription and met with a hearty response. The cost was as follows:

Salaries for six inspectors, laborers, etc.	$1,133.02
Supplies	157.94
Stationery, postage, leaflets	194.75
	$1,485.71

The newspapers assisted admirably by giving the work the needed publicity. At least every week a story was run by each city paper. The general public also gave their hearty support, only two cases of refusal to comply with our requests occurring. The demand for the continuance of the work seems universal over the city.

WHEN DOES THE COST OF SPRAYING TRUCK CROPS BECOME PROHIBITIVE?

By V. I. Safro, *Louisville, Ky.*

At this time, the item of cost of insect control work is receiving considerable attention. Many entomologists, as well as growers, have had the general impression that when the cost of spraying reaches within an appreciable fraction of the *profit* expected, it becomes prohibitive. They forget that the investment itself represents very often a much larger amount of money than the profit expected.

In the writer's experience, an incident occurred that will be of interest in this connection. In one case it was necessary, for various reasons, to spray a certain patch of thrips-infested onions as many as eleven times in one season, each application costing from $1.50 to $2.50 per acre. Many entomologists would consider this cost entirely prohibitive. However, this procedure was not only not prohibitive, but was an economic necessity.

In the example mentioned, the grower concerned made this statement: "We have already spent our prospective profits; we cannot make any money; but if the spraying is a success, we may break even." When, as was the case, from $150 to $175 per acre has been expended in growing onions and a severe epidemic of onion thrips threatens, it is certainly good business to spend even as much as $50 per acre, if necessary, in spraying to save even as little as $100 of the original investment.

The cost of the spraying of fruit trees for any season, or a series of seasons, cannot be figured as easily on the basis of annual returns as

it can with annual truck crops in which the entire business transaction is completed within the one year. In the case of truck crops, the cost of spraying may be charged to operating expense, whereas it is reasonable to allow at least some of the expense of fruit tree spraying to be charged to increased capitalization, being in much the same category as the extension of railroad lines—a charge which is not proper to consider under operating expense.

In the control of pests that attack a wide range of food plants, the usual statement made is that, in the particular field concerned, the results would be only temporary and that in several days the field would again be infested because of the migration of the insects from nearby weeds and cultivated plants. This, in itself, has been considered a prohibitive factor; but under our own observations this is not necessarily true.

As typical of such problems may be mentioned Jassid attacks on beans in the state of Florida. It is quite true that, upon spraying a field, it becomes infested again later on. However, growers have found spraying advisable, the purpose being to keep down a sufficient proportion of the epidemic to permit the plants to become hardier and reach that stage of development that will enable them to withstand a heavy attack of these pests, which, early in the season in untreated fields, have destroyed young, tender plants outright.

An attack of insects on truck crops threatens the definite destruction of part or all of that particular season's business. We have seen hundreds of acres of cantaloupes totally destroyed by aphis, and large plantings of onions rendered unmarketable by thrips. Destructive epidemics of this kind emphasize the necessity of rearranging our ideas concerning the factors that render the cost of spraying prohibitive.

What then should be the true economic attitude on this subject? To formulate a rule covering this problem is, indeed, a difficult matter. The writer, therefore, submits the following suggestion in order that discussion may ensue, as a result of which a definite rule maybe developed which will apply eventually not only to truck crop spraying, but to the spraying of fruit trees as well:

Rule: The cost of spraying truck crops for pests that threaten to destroy all or a large part of the crop does not become prohibitive until the immediate application in view, together with such following farm operations as can be definitely foreseen, have a total cost in excess of the reasonable expectation of gross returns from the crop in question.

It is true that there will be many cases of applications, the necessity for which cannot be definitely foreseen, with the result that at the end of the season it will have been ascertained that the cost of spraying

during the entire season actually did exceed the gross receipts from the crop. Nevertheless, the rule should still hold. As soon as an application has been made, the cost should immediately be charged up to the investment; we can, therefore, very readily imagine a condition that would finally result in a large amount of money being paid out in the *late* part of the growing season in order to recover by such late application all or part of the money previously expended in spraying, as well as other farm operations, carried on in the *earlier* part of the season.

The rule specifies, "Pests that threaten to destroy all or a large part of the crop." What, then, shall be the attitude of the grower in a case of uncertainty as to whether the destruction of all or a large part of the crop is actually threatened?

It seems to the writer that the grower should not give himself the benefit of any doubt. If there is a doubt at all, then he should play safe by considering the destruction as actually threatened.

In this same category the writer would place the problem of parasitism. Parasites may possibly appear in sufficient numbers to afford such an effective control as to render spraying unnecessary, provided the epidemic of parasites could have been definitely foreseen. Unless, however, such parasitism can be definitely foreseen, then the attitude of the grower must be that of the business man in respect to fire insurance, who, knowing that the chances of his business being destroyed by fire are less than one in one hundred, nevertheless carries insurance against such a contingency as a business necessity.

It will be noted that we have said nothing regarding the market, and the writer has done this advisedly. Whether the market price be high or low does not affect the need of getting the greatest amount of product and the highest grade possible; in fact, when the market price is low, there is all the more reason that the *individual* grower turn out the best crop he can. But the essential point is that, even in cases where the market price may fall below the freight charges, this is a contingency that the grower can very rarely foresee at the time he must deal with his spraying problems; and, therefore, the possible course of the market in the future should not affect his efforts or expenditures in taking care of his crop after he has incurred the expense of planting it.

A DEVICE FOR SOWING GRASSHOPPER POISON

By T. H. Parks, *Kansas State Agricultural College*

The seeder shown in the accompanying photograph was improvised, during a grasshopper campaign last summer in western Kansas, to off-set the labor necessary in applying poison bran mash over many acres of land. This seeder was used extensively in Sherman and Thomas counties, and proved to be a success, one man covering as much ground with it as three men sowing the mixture by hand. It was constructed after the manner of an alfalfa seeder occasionally used in that section of Kansas, the dimensions being enlarged to meet the needs of the bran mash.

The seeder consists of a canvas bag which is strapped over the shoulder of the operator and fitted with a feeding device consisting of a canvas sleeve and swinging tube made of tin or galvanized iron, as shown in the photograph. The first one was made on the Kuhrt farm in Sherman County, Kansas, and constructed from an old grain sack, and two empty molasses cans cut and soldered to make the tube.

Some disappointment was encountered before a seeder of the right dimensions was constructed and, after experimenting, it was found that the machine shown in the photograph not only scattered the mixture properly and evenly but covered the ground very rapidly. The dimensions of the metal tube are as follows: Length, 28 inches; diameter at upper end, $2\frac{1}{2}$ inches; diameter at lower end, $1\frac{5}{8}$ inches. Over the opening at the lower end is soldered two short wires bent around in the shape of a U, and crossing each other at right angles at exactly the center and about one inch below the opening of the tube. These wires are soldered to the edge of the tube and soldered together where they cross. Their purpose is to scatter the mixture evenly and thinly as it leaves the tube, being swung by the operator. The canvas sleeve is 12 inches long, 13 inches in circumference at the upper end and 8 inches at the lower end, which fits tightly over the upper end of the metal tube. These were found to be the proper dimensions to allow the mixture to work down into the tube, and to allow the tube to be swung over an 180 degree angle by the operator walking through the field. On a still day the poison bran mash was scattered in this way, evenly and thinly, over a strip of ground sixty feet wide. This enabled one to cover the infested fields in a short time and do the work very thoroughly.

It was found that a seeder made after the above dimensions scattered the poison bran mash at the rate of twenty pounds to four acres, which is recognized as the proper amount to apply under Kansas con-

1

2

3

1 Scene of the grasshopper poisoning in western Kansas; *2* Poison bran mash seeder in operation; *3* Close view of seeder.

ditions. The mixture can be sown thick or thin depending upon how rapidly the operator travels through the field. Where grasshoppers were found to be very numerous, by walking slowly and whirling the tube regularly the mixture was scattered much thicker than where they were found to be less numerous and the operator walked at a natural gait.

It is necessary to have the oranges or lemons ground through a food grinder in order to prevent the tube from becoming stopped up by the peelings. Many farmers in these counties used old grain sacks cut in two at the middle and strapped over their shoulders in the manner shown in the photograph. One objection to using a grain sack for the bag is that the sweetened mixture penetrates through the cloth and soils the clothes of the man operating the seeder. The writer prepared a bag made of water-proof canvas which overcame this difficulty. Hardware dealers generously supplied the galvanized or tin tubes at the cost of the material plus labor, and sold them at forty cents each. The rest of the outfit was made in a few minutes at the farms. Where it was scattered with these seeders, the grasshoppers ate all of the posioned bait in a few hours and every particle of the poisoned bran was utilized. Owing to their cannibalistic habits, many grasshoppers apparently died from eating the dead bodies of their less fortunate brothers. It was estimated that 75 to 90 per cent of the grasshoppers were killed by one application of the poison bran mash, scattered by means of these seeders. Public demonstrations were given in each township in Thomas County, and the general opinion as expressed by the farmers was that this cheap and simple device made it possible for them to scatter the poison bran mixture over a much greater acreage than they had heretofore attempted. This type of seeder is recommended by the writer to any who may be supervising grasshopper campaigns in the future.

NEW PARASITE CAGES

By C. E. Pemberton and H. F. Willard, *U. S. Bureau of Entomology, Honolulu, T. H.*

During recent studies of introduced *Braconid* parasites of the Mediterranean fruit-fly (*Ceratitis capitata*) in Hawaii, the adoption of certain improved cages for confining the parasites has given such satisfactory results that it is considered important to place on record a description of these cages.

A glass tube, jar or chimney, in one form or another, with one or more openings tightly plugged or covered, has been usually used by

entomologists for confining living parasites. Of these, the plain test-tube, in several sizes, or the larger sterilizing tube, have been most commonly used. These will always be necessary and for many purposes of great value. However, a free circulation of air through such cages is never possible. In some respects this is an abnormal condition for the enclosed parasites. For general breeding purposes with parasites of the fruit-fly, where moist and often decaying fruit must be placed with them, the elimination of gases from decaying fruit and the prevention of moisture-condensation on the sides of the cage is of the utmost importance.

The main principle involved in the construction of the types of cages herein described is simply one of free-air circulation. Pl. 25, fig. 1 shows the style of cage now in use by the writers. It is invaluable as a cage for the *Braconid* parasites now under investigation. A year's trial has proved its merits over all others for most purposes in general parasite work. It is of simple construction, inexpensive and easily made by hand. The bottom and one end are of wood, both sides and one end are of fine copper screen and the top is of glass which is fitted to slide free from the cage when necessary for cleaning, as shown in Pl. 25, fig. 2 where the glass top has been partially drawn out. In the wooden end a small opening or door is cut. The construction of the door, as illustrated in Pl. 25, fig. 2, has been found most satisfactory. It is sawed from the piece composing the end of the cage, by two oblique cuts. The cut sides of the door are then padded by covering with thin strips of cardboard tightly glued on. This door then fits snugly into the opening, is tighter than a hinged door and more easily made. The glass top is important. This permits easy observation of the parasites within, even with a binocular microscope when desired, and seems also of value in allowing necessary light to enter. The cages now in use are 7 by 3 by 2 inches in size.

The three species of *Braconid* parasites of the fruit-fly now established in Hawaii have been very successfully handled in this type of cage. Oviposition and feeding is quite normal. Individual lots of parasites have been kept in such cages for nearly two months without need, at any time, for cleaning the cages and without any attention being given them other than the daily removing and replacing of leaves containing drops of honey and water for food. By using such cages a great amount of time is thus saved when large numbers of parasites are being handled. Parasites confined in glass test-tubes must be removed to clean tubes every two or three days. This is a slow and laborious process when large numbers must be transferred. "Sweating" in the glass test-tube containing parasites is a great annoyance and often hastens mortality unless constant attention is given the tubes. This never occurs in the

1 Copper screened box cage; *2* Copper screened box cage. Showing construction of door and method of removing the glass top; *3* Open glass tube cage. Both ends are open and are closed by copper screened caps.

screened box cage, even when a moderate quantity of moist or decaying fruit is placed with the parasites for a day or more.

A second type of cage, illustrated in Pl. 25, fig. 3, has been found useful and is, in some ways, also superior to the glass tube open at one end and plugged with cotton. This is a straight glass tube, 1 to 1½ inches in diameter and 6 to 9 inches long. It is open at both ends. Copper screened caps fit into the ends and are made just large enough to fit into place tightly. This tube also permits free air circulation within. It is of particular value as a container for individual parasites from which oviposition, or other data, is being determined. In such cases food and fruit, or other material, may be placed almost in contact with the parasite without danger of gases of fermentation accumulating and killing or injuring the individual from which valuable records may already have been secured.

Such cages as here described are of importance only in confining parasites considerably larger than the mesh of the copper screening used. The shape of the cage is not entirely essential, the free circulation of the air and abundant lighting being the important points.

These improved cages are most useful in a study of the active life functions of parasites. When it is desired simply to prolong or preserve the life of parasites, the closed test-tube or larger closed sterilizing tube is possibly better. The parasites are then best preserved and the energies least expended when given but little food and kept constantly in partial darkness.

THE BIOLOGY OF CŒLINIDEA MEROMYZÆ (FORBES)

By E. O. G. Kelly, *Entomological Assistant, Branch of Cereal and Forage Insect Investigations*

References to this parasite in literature are very few. It was discovered by Dr. S. A. Forbes in 1883, having been reared by him from the pupa of *Meromyza americana* at Cuba, Ill., April 25, 1883. Dr. Forbes described the parasite in his thirteenth report of the state entomologist of Illinois, as *Cœlinius meromyzæ*, stating that "the abundance of these parasites in this field may be inferred from the fact that out of fifty-five larvæ obtained here, only twenty-one developed the fly (Meromyza), and the thirty-four remaining all gave origin to Cœlinius (Cœlinidea) which continued to emerge from May 6 to May 19. Sweepings of these infested fields in April yielded none of this species, and there can be no doubt that the eggs are deposited within the bodies of the larvæ in autumn."

Dr. Forbes' conclusion was quite the natural one. No one at that

time would have thought to look for a parasite ovipositing into the egg, knowing the adult issued from a pupa. The comparatively large size of the parasite precluded such an idea. However, within the last few years, several entomologists have made such observations, and there are now on record about a half dozen species of parasites which have this method of oviposition in the egg, with the subsequent emergence of the adult parasite from larva or pupa of its host.

This parasite was again noted in 1891 in Insect Life, as having been found at Ames, Iowa, by Prof. Herbert Osborn, where it preyed upon *Meromyza americana* so abundantly that the injurious multiplication of the host was not feared. It was reported from Canada a year later in *Report No. 22 of the Entomological Society of Ontario*, by Dr. C. J. S. Bethune. In a letter dated April 11, 1916, addressed to the writer, Mr. A. B. Gahan, of the U. S. Bureau of Entomology, states that he has determined the species from a number of localities in the United States. *Meromyza americana* has been recorded from nearly every state in the Union, and this parasite evidently occurs wherever its host occurs. The parasite has been recorded from Canada to Texas, and specimens in the United States National Museum, together with the records in the Cereal and Forage Branch of the Bureau of Entomology, indicate that it is widely distributed in the United States, east of the Rocky Mountains.

The generic name, Cœlinidea, was proposed by Viereck, *Proceedings U. S. National Museum*, Vol. 44, page 555, for Cœlinius (Nees) of authors.

While observing the habits of *Meromyza americana* in the fall of 1908, the writer observed, on September 22, a small Hymenopteron ovipositing into the long white eggs of the Meromyza. A note made by the writer at that time, which has since been on file in the office of Cereal and Forage Insect Investigations of the Bureau of Entomology, states that a small Hymenopteron was observed in the act of ovipositing into the long white eggs of *Meromyza americana*, which were on the leaves and stems of wheat plants. She thrust her abdomen forward between her hind legs, beneath her body, very similar to the position taken by *Aphidius testaceipes*, while ovipositing, and with a sharp, quick jab, struck the white egg. This species was again observed ovipositing on October 2, 1908.

The parasites thus ovipositing into the Meromyza eggs were collected for further study and identification, and were submitted the following winter to Mr. J. C. Crawford for determination. However, Mr. Crawford was not in position to identify them at that time, and therefore they were put away for future reference. They were recently determined by Mr. A. B. Gahan as *Cœlinidea meromyzæ* Forbes.

The Meromyza eggs into which these parasites oviposited were collected and placed in a large vial, where they were kept with especial care until the following spring, but no parasites issued from the eggs, and upon careful examination they were found to be mere shells.

At the time the oviposition was first observed, the relative size of the parasite and the egg was carefully considered, and the writer wondered how such a large parasite could mature in so small an egg, it being fully four times as large. However, the following spring, the writer observed *Diplazon la tatorius* Forb. ovipositing in a similar manner into the eggs of a Syrphid, which had been placed among a number of aphids, on the stems and leaves of a chrysanthemum. The Syrphid eggs were collected for observation. They soon hatched into tiny Syrphid larvæ, which were supplied with aphids for food; they matured as larvæ, and pupated, but instead of a Syrphid adult from the Syrphid pupa there issued an adult of *Diplazon lætatorius* (JOUR. ECON. ENT., v. 7). The writer was then convinced that his observations the preceding fall on *Cœlinidea meromyzæ* were correct, but that improper methods had been used in an effort to rear the parasite. The Meromyza eggs should have been permitted to hatch and mature on the wheat plant.

Since the first observation in 1908, this parasite was not again observed until the fall of 1914, although diligent search had been made for it in the fields, and a large number of Meromyza larvæ had been collected and reared to maturity in an attempt to rear the parasite.

During the summer and fall of 1914 a large number of wheat plants were secured from different localities in Iowa, Missouri, Illinois, Arkansas, South Dakota, Oklahoma, Kansas, and Nebraska. Many of these wheat plants were infested with *Meromyza americana* Fitch. Upon receipt of this material at the laboratory it was placed in breeding cages, each consisting of a large tin can with a small hole punched in one side near the top into which a glass vial was inserted for the purpose of obtaining the mature Meromyza and parasites as they issued. The infested wheat plants which were placed in the warm room of the laboratory produced adults of *Meromyza americana* late in the winter, and soon after these began to issue the parasite *Cœlinidea meromyzæ* began to issue from the same material. Upon comparing these parasites with those collected in September, 1908, they were found to be identical.

Now that the writer was convinced that he had observed this parasite ovipositing into the eggs of *Meromyza americana* in the fall of 1908, he at once set about to rear the parasite in the laboratory. Fortunately a number of Meromyza adults were issuing in early February, in the laboratory, and they were at once placed on potted wheat plants, under

cover. When they had deposited a number of eggs on the plants, several of the parasites were introduced; they immediately began ovipositing into the eggs of the Meromyza, readily verifying the observation of 1908. The interesting method of oviposition was witnessed at this time by Messrs. Packard, Larrimer, and Wade, who were working with the writer at the Wellington (Kan.) laboratory. These men, together with the writer, watched the development of the host and the parasite. It required only a few days for the Meromyza eggs to hatch. The host larvæ matured and reached the pupal stage in about ten weeks, and in about twelve weeks the adults of both host and parasite matured. Further observation in the field and laboratory indicated that the adults of the host and parasite matured about the same time. This, of course, would be necessary in the life economy of the parasite.

In comparing the size of the host and parasite, it was found by Mr. Larrimer that the egg of *Meromyza americana* averages about 1.12 mm. in length, and .28 mm. in diameter, while the Cœlinidea egg measures on an average about .18 mm. in length and .04 mm. in diameter; the *Meromyza americana* egg being seven times larger than the Cœlinidea egg. The Cœlinidea eggs were dissected from the eggs of the Meromyza. The egg is watery white, oblong, with oval ends, very similar in shape to the Meromyza egg.

The adult parasites were introduced into the cage containing the Meromyza eggs, on the 10th of February, and they began ovipositing into the eggs at once, apparently not missing an egg. The Meromyza eggs began to hatch on the 12th of February, continuing to hatch for the next few days. The larvæ did not develop very rapidly, and were yet quite small on the 10th of March. On this date a number of them were measured, the average being about 2.66 mm. in length and .36 mm. in diameter. These larvæ were then dissected and Cœlinidea larvæ removed from them, which larvæ measured on an average .64 mm. in length and .19 mm. in diameter. The Cœlinidea larvæ were in the fatty tissues of the Meromyza, and apparently were not disturbing the alimentary tract, thus not interfering with the development of the Meromyza larva.

Dissecting the Meromyza larva in search of the Cœlinidea larva was rather disastrous to the latter. However, a few were successfully dissected, and it was assumed from the data thus obtained that the Cœlinidea egg hatches very shortly after the egg of the Meromyza, and the two larvæ develop along together, the Cœlinidea larva not maturing until after the Meromyza pupates.

According to further observations in the laboratory by Messrs.

Packard, Larrimer, and the writer, it was found that the larva feeds greedily during the week or two following the pupation of the Meromyza until it consumes the juices of the Meromyza larva within the pupal case, where it also pupates later. The pupal stage of Cœlinidea is very short in the laboratory, being not more than eight or ten days. However, in the field, observations indicate that the pupal stage may be longer.

Observations in the field during the spring of 1915 indicated that the adult parasites were abroad at the same time as the Meromyza adults, and they readily oviposited into the eggs of the Meromyza in the field. Collections of Meromyza larvæ made in May and June gave up the parasites in about twelve to fifteen weeks after oviposition was observed, some of the parasites, however, remaining in the plants until fall. During early September, Meromyza adults were quite plentiful, depositing a large number of eggs on the wheat plants. But it was not until the latter part of September that *Cœlinidea meromyzæ* were observed, and then in large numbers depositing eggs into the Meromyza eggs which were just about ready to hatch. Some of the infested wheat plants collected in November were placed in a warm room at the laboratory and from these issued adult Meromyza and a number of adult parasites in January, 1916. A lot of plants collected at the same place were left in outdoor cages, but from these the host and parasites did not issue until the middle of April.

The indications are that there are two annual broods of the parasite. However, this may vary, because there are some indications that there are more than two broods of the host. It appears probable that if weather conditions are right, and the Meromyza puts out an extra brood, there will be an extra brood of the parasite. From a number of infested plants collected in 1914 and 1915, the percentage of parasitism was apparently not sufficient to be a controlling influence on the host. However, Dr. Forbes and Professor Osborn state that this parasite is evidently a controlling parasite of the wheat bulb-worm in Illinois and Iowa. This may be universally true, because in localities observed there has not yet been a really serious outbreak of *Meromyza americana*, though it frequently does more or less damage to wheat.

THE EFFECT OF CERTAIN CHEMICALS UPON OVIPOSITION IN THE HOUSE-FLY (MUSCA DOMESTICA L.)[1]

By S. E. Crumb and S. C. Lyon

During the summer of 1916 the writers conducted a series of experiments with house-flies to learn, if possible, what substances in horse manure were capable of inciting them to oviposit. In the course of these experiments it was learned that the ether extract possessed this quality in some degree but that the chief incitant remained after complete ether extraction and was a product of fermentation. Further investigation gave positive evidence that this oviposition stimulant was carbon dioxide. A limited series of experiments with ammonia gave negative results.

As the conclusions to be drawn from our experiments did not agree with those of Mr. Richardson[2] it was decided to devise an apparatus for more thoroughly testing the effect of ammonia on fly oviposition and the experiments both with ammonia and carbon dioxide have been continued during the present summer.

The ammonia-testing apparatus (see Fig. 27) consists of a water tank of galvanized iron 7 feet long, 6 inches wide, and 9 inches high set on six legs about 3 feet high and provided with nipples every foot along the bottom. Each of these nipples is connected by tubing with a six-quart can which rests on the table beneath the tank and may be called the compression chamber. This compression chamber is further connected with a pint milk bottle by means of a glass tube which dips beneath the surface of the liquid in the bottle. This bottle rests on the table in front of the compression chamber and contains the ammonia or water used in the experiments. The exit from the milk bottle is through an upright glass tube bearing at its apex a porcelain drying funnel about three and one-half inches in diameter. This funnel has a fixed perforated, porcelain partition about one inch below the lip which bears the material provided as a nidus.

The flow of water from the tank to the compression chamber is regulated to any desired amount by adjustable clamps on the connecting rubber tubes and, as all connections in the apparatus are air-tight, an amount of water admitted to the compression chamber displaces an equal amount of air through the material in the funnel after it has

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[1] Published by permission of the Chief of the Bureau of Entomology.

[2] Charles H. Richardson. The Response of the House-Fly to Ammonia and Other Substances. Bull. 292, New Jersey Ag. Ex. Sta., Feb. 1, 1916. A Chemotropic Response of the House-Fly (Musca domestica L.). Science, new series, vol. 43, 613, April 28, 1916.

bubbled through the liquid in the bottle where the rate of flow is indicated by the number of bubbles produced per minute.

In selecting a material through which to percolate the odors to be tested, it was necessary to obtain something having a texture satisfactory to the ovipositing fly but which did not possess further inciting qualities. After testing asbestos, absorbent cotton, abraded blotting paper, ground chaff, animal charcoal, wheat bran and some other substances, the bran was selected as most nearly fulfilling these conditions. A special grade of this material was obtained which was nearly pure husk. This was thoroughly washed and dried in the sun and before use was moistened, packed in the funnels, and sterilized by steam for an hour or more. The use of this bran did not entirely eliminate eggs in the checks probably for the reason that the texture of the medium may be a secondary stimulant to oviposition.

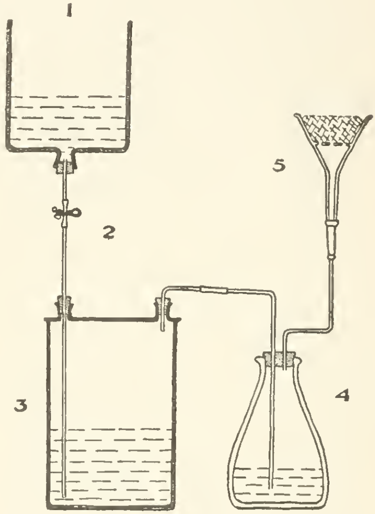

Fig. 27. Cross section of one unit of apparatus for testing the effect of ammonia on house-fly oviposition: 1, Cross section of water tank; 2, connecting tube between water tank and compression chamber. In use the spring clip was replaced by a tubing clamp for regulating the rate of flow of the water; 3, compression chamber; 4, milk bottle containing liquid to be tested; 5, porcelain funnel bearing wheat bran on the perforated porcelain partition.

Each unit of the apparatus for testing carbon dioxide consists of a milk bottle equipped as in the ammonia apparatus (see Fig. 27) excepting that the connecting tube from the compression chamber in the ammonia apparatus is replaced by a dripping funnel having a ground-glass stopper. The bottle was charged with pure carbonate in a little water and the dripping funnel with pure sulfuric acid diluted one to four. When the apparatus was in operation, the acid was allowed to drip into the bottle at such a rate that a continuous slow generation of carbon dioxide resulted. Calcium carbonate was used in the bottle to some extent but the sodium compound was found more satisfactory and was the carbonate chiefly employed. In interpreting the results of the experiments it should be borne in mind that the products of the reaction between the carbonate and sulfuric acid are a sulfate and carbon dioxide and that the sulfate in both cases is non-volatile at ordinary temperatures.

The flies used in the experiments were caught in fly traps and liberated in a cage 6 x 6 x 21 feet square in which the apparatus was set up on a level table. This cage had the roof and one side solid while the ends and west side were of wire screen. Flies of various species were liberated in the cage but all of the eggs obtained in the course of the investigation were placed in a breeding chamber and the house-fly was the only species obtained from the large number of flies bred.

The tests were run from about 10.30 in the morning until 4.00 in the afternoon and at the close of the exposure the funnels were removed and the number of eggs in each recorded. The flies distributed themselves about equally upon the series of funnels and exhibited no noticeable tendency to congregate especially at any of the odors tested. Only in the case of the strongest dosages of ammonia was there a distinct repellent effect after the experiment had been run for several hours.

In the following tables the results of our experiments are summarized:

Table 1.—Comparison of Results Obtained with Carbon Dioxide and Air

Chemicals	Inclusive Dates	Number Days Run	Total Eggs	Number of Units	Average Number Eggs per Unit	Per Cent of Total Unit Average
Carbon dioxide	6:20 to 7:10, '17	11	5,144	47	109.4	
Air (no current)	6:20 to 7:10, '17	11	291	32	9.1	
Carbon dioxide	8:2 to 8:9, '17	7	3,737	28	133.4	
Air (with current)	8:2 to 8:9, '17	7	294	28	10.5	
Totals:						
Carbon dioxide			8,881	75	118.4	92.4
Air			585	60	9.7	7.6

The above series of experiments consists of two divisions, as indicated, in one of which the conditions in the two sets of apparatus were duplicated, air being forced through the bran in the checks after bubbling through water, while in the other no current of air was provided for the checks to correspond with the gentle current produced by the evolution of carbon dioxide. There was also another difference in the two divisions. In the first the two sets of units were intermingled and set only from 4 to 6 inches apart while in the other the checks were grouped at one end of the series so as to reduce the possibility of their being influenced by the proximity of the funnels evolving carbon dioxide. It will be noted that the checks intermingled closely with the carbon-dioxide units and emitting air at the rate of from 10 to 250 bubbles per minute yielded practically the same average number of eggs as those checks which were isolated and without air current.

TABLE 2.—COMPARISON OF THE RESULTS OBTAINED WITH CARBON DIOXIDE AND AMMONIA

Chemical	Inclusive Dates	Number Days Run	Total Eggs	Number of Units	Average Number Eggs per Unit	Per Cent of Total Unit Average
Carbon dioxide	8:10 to 8:28, '17	9	9,768	27	361.8	91.4
Ammonia	8:10 to 8:28, '17	9	1,320	39	33.8	8.6

The two sets of units in the above experiments were placed from 4 to 6 inches apart in a series and air was bubbled through the ammonia at rates varying in different units from 12 to 240 bubbles per minute. The lower rate gave the bran only a faint ammoniacal odor at the end of the experiment while the higher gave the bran a powerful odor of the gas. The ammonia used was of U. S. P. strength diluted with an equal volume of water, and one hundred cubic centimeters of the liquid were placed in each bottle. The experiments were run the greater part of the time with five ammonia units and three carbon dioxide units equably distributed, thus giving the ammonia the greater opportunity for profiting by chance oviposition. It will be noted that the carbon dioxide received 91.4 per cent of the unit average of the eggs deposited while the ammonia received 8.6 per cent. This ratio is very nearly the same as that shown in Table 1, in which carbon dioxide and air are compared.

TABLE 3.—COMPARISON OF THE RESULTS OBTAINED WITH AMMONIA AND AIR

Chemicals	Inclusive Dates	Number Days Run	Total Eggs	Number of Units	Average Number Eggs per Unit	Per Cent of Total Unit Average
Ammonia	8:29 to 9:8, '17	9	1,170	36	32.5	32.6
Air	8:29 to 9:8, '17	9	2,424	36	67.3	67.4

Eight units divided equally between the ammonia and air were run throughout these experiments. The ammonia was of the strength and quantity used in the previous series and an equal amount of water was placed in the check bottles. The two sets were placed alternately about one foot apart and three of the adjacent pairs of bottles, one containing ammonia and the other water, had air bubbled through the liquid at equal rates, varying in different pairs from 5 bubbles to 250 bubbles per minute, the usual series being about 12, 24, and 180 bubbles per minute respectively. An additional check bottle had no air current and the remaining ammonia had air bubbled through the liquid at some rate intermediate with the above. No oviposition

occurred which could be ascribed to any particular dosage of ammonia though the north end of the series, which was usually occupied by the heavier dosages, produced most eggs both on the ammoniated bran and the checks but when the lighter dosages were shifted to this end the heavy oviposition continued to occur at the north end of the series. The check funnels received 67.4 per cent of the unit-average of the eggs deposited and received decidedly more eggs than the ammoniated units on seven of the nine days the experiments were run.

A careful analysis of Mr. Richardson's experiments leads us to believe that the apparent discrepancy between his results and ours is only in drawing conclusions. Certainly he obtained marked oviposition in no case where carbon dioxide was undoubtedly absent and we believe that this was the oviposition-inciting principle in his investigation as well as in our own.

THE LIFE-HISTORY OF THE OKRA OR MALLOW CATERPILLAR (COSMOPHILA EROSA HÜBNER)

By H. L. Dozier, *University of Florida, Agricultural Experiment Station*

Introduction

The attention of the writer was first called to this insect on July 16, 1916, on passing by an okra field at Gainesville, Fla., and observing badly eaten leaves of the plants. A search quickly revealed the culprit to be the larva of some noctuid.

As I shall mention later in this article, the work of this larva has probably been attributed to that of *Autographa brassicæ*.

Since this insect was of undoubted economic importance, a study of it was begun upon which the present paper is based. All investigations were carried on at Gainesville, Fla.

Dr. Chittenden[1] calls this the Abutilon moth but here in Florida it would seem more appropriate to call it the okra or mallow caterpillar, since it is found on such a large number of the Malvaceæ.

History

The moth was first figured by Hübner (Zeitr. 287, 288) in 1818. It was fully described by Guenée who describes the larva, under the name of Cosmophila, in a few words, giving its food plant as Hibiscus. Comparatively little mention of this species has been made since this time.

[1] Bulletin No. 126, Bureau of Entomology. This bulletin contains a full bibliography.

Distribution

Cosmophila erosa is principally a southern species and continues breeding the year round with scarcely any intermission. Moths have been captured in various parts of the South from July throughout the winter till May.

Grote gives Savannah, Ga., and Alabama as localities. According to Riley, larvæ of all stages were found in March, 1882, feeding on *Urena lobata* at Crescent City, Fla. They could not be found on any other plants.

The following data from the manuscript of the List of Florida Lepidoptera by the late Mr. Grossbeck were supplied to me by Mr. Frank E. Watson of the American Museum of Natural History: "*Cosmophila erosa* Hbn., Lakeland, May 5, Fort Myers, April 26, La Belle, April 27 (Am. Mus. Nat. Hist.); South Bay, Lake Okeechobee, April 29, 30 (Am. Mus. Nat. Hist., Davis.); Indian River (Am. Mus. Nat. Hist.); Chokoloskee (Barnes); Hogtown Creek, Gainesville, October 1 (F. E. Watson).

"Extends northwards to Massachusetts and Montreal, westward to Kansas and southward through Mexico and the Antilles to South America. Occurs also in South Africa and in the Oriental and Australian regions."

Observations

The writer first found the larvæ of this species doing serious damage to okra plants July 16, 1916, on several separately located plots. The damage in these cases was very noticeable. On this date, the plots were searched carefully and no adult moths were found, only larvæ—for the most part fullgrown, and numbers of pupæ. An okra field examined August 27 showed larvæ and pupæ in abundance.

On August 8, it was noticed that nearly every leaf on numbers of the cotton rose (*Hibiscus mutabilis*) plants on the station grounds was seriously damaged. On this date and on the 15th, the larvæ were very abundant.

Large numbers of pupæ and a few larvæ were collected August 23 on bushes of the flowering maple (*Abutilon striatum*). The work was similar to that done to okra plants but even more serious. The beauty of these bushes as ornamentals was ruined, they being nearly defoliated. Breeding was kept up steadily and, on September 2, eggs and larvæ were collected. Eggs were found in abundance on these plants again on October 14.

The caterpillars were found to have been working on plants of the swamp or rose mallow (*Hibiscus moscheutos*) August 24 and a pupa was found on one of the leaves.

A search of chinese mallow (*Hibiscus sinensis*) plants on the university grounds showed the presence of this caterpillar. Their work on these plants was not very noticeable at this time although a new phase of injury was observed. Numbers of the unopened flower buds were found to be eaten into, the culprit in a number of cases being caught red-handed in the act. The leaves showed the same typical injury, although in this case the young tender foliage seemed to be markedly preferred. Larvæ were found at work upon these plants October 14 and the injury was now decidedly noticeable. This species of Hibiscus seems to be less attacked than any of the others, probably on account of the tougher texture of its leaves. A number of pupæ were found on these plants November 10.

As this species was found to attack other plants of the Malvaceæ, it was thought highly probable that it would be found to attack cotton. Therefore, a careful search was made over a small cotton field where a large number of the different varieties of cotton were being tested. The work of this species was noticed scattered here and there indiscriminately on the different varieties, the insect seeming not to discriminate between any of them. After a careful search, a few caterpillars, pupæ, and empty pupa cases were found. The damage, however, was hardly noticeable and entirely negligible in this case. No other species of caterpillar was found working on the cotton.

This insect was found attacking the roselle (*Hibiscus sabdariffa*) plant at Gainesville, Fla., August 30, and a pupa of the same was sent in September 19 by a correspondent from Kuhleman, Fla., on roselle. It probably occurs all over the state wherever the roselle plant is cultivated.

On September 1, a few plants of roselle growing in the insectary were found to be infested with these caterpillars. Several bell pepper plants growing nearby were also found to contain a number of pupæ and evidence of the work of larvæ. Due to the close proximity of these pepper plants to those of the roselle, their being attacked would seem more or less accidental.

Closely Related and Associated Species

According to Mr. Grossbeck (*loc. cit.*), two or three other species of *Cosmophila* occur in Florida, *Cosmophila xanthindyma* Bd., *C. doctorium* Dyar, and ? *C. texana* Riley (determination doubtful).

Cosmophila larvæ, when on cotton, are often mistaken for those of *Alabama argillacea* but a person familiar with these can readily distinguish between them. The two, however, are very much alike in their early stages. The adult moths do not look like those of *Alabama*.

On plants of the cotton rose, larvæ of *Chloridea virescens* Fabr. were found August 4 in association with those of *Cosmophila*. Together, they were doing serious damage.

Chloridea virescens is known as the true tobacco bud worm moth. The following description will serve to distinguish between these two insects in the different stages:

Chloridea virescens

Description. *Larva:* Smooth, soft, translucent, green in color. Finely speckled with pale yellowish spots, body covered with fine translucent hairs. These fine translucent hairs are lacking in *Cosmophila*.

Pupa: Blunter anal extremities than *Cosmophila* and conical projection on front of head.

Adult: About the same size as *Cosmophila*. Has its front wings light green in color crossed by three light bands. Each band is relieved by a dark greenish shade on its outer border; hind wings silvery white or slightly tipped with dusky markings.

Larvæ feed upon Solanaceous plants; has been reared from *Solanum seiglinge* and *Physalis viscosa*.

Both *Chloridea virescens* and *Cosmophila* are strongly attracted to lights. With them are taken large numbers of another noctuid that greatly resembles *C. virescens*. This is *Shinia trifascia* Hübner and can be distinguished from the latter by its smaller size and slight differences in markings.

Food Plants

Riley states that the food plant of *Cosmophila erosa* is *Urena lobata* and that eggs and larvæ were found in September 1882, on *Abutilon avicenna* at several localities in the District of Columbia. Larvæ and eggs were found on leaves of *Malva rotundifolia* at Giesborough, D. C., October 28, 1916.

Chittenden gives an account of its attacking Abutilon and hollyhocks at Diamond Point, Va., and states that it was found on okra at Washington, D. C., in 1912. He states that the larvæ seem to prefer Abutilon to hollyhock.

The writer has found this insect feeding on the following plants in order of damage done at Gainesville, Fla.: Flowering maple (*Abutilon striatum*), okra (*Hibiscus esculentus*), confederate or cotton rose (*Hibiscus mutabilis*), roselle (*Hibiscus sabdariffa*), Chinese mallow (*Hibiscus sinensis*), cotton (*Gossypium* spp.), swamp or rose mallow (*Hibiscus moscheutos*), and bell pepper (*Pepperomia* sp.).

Economic Importance

The work of *Cosmophila erosa* on okra has doubtless been attributed to that of *Autographa brassicæ*. The former seems to be one of the worst pests of okra.

Roselle is fast becoming an important commercial plant in southern Florida where it is grown for making jelly. *Cosmophila* is capable of becoming a very serious pest to this plant.

As an enemy of ornamentals, such as the different varieties of Hibiscus, Abutilon and hollyhocks, this insect seems to be a serious one, capable of ruining the appearance of the plant in a very short time. Large numbers of Hibiscus plants are grown for commercial purposes in the nurseries of the state and nearly every private home garden contains a few of these plants for decorative purposes.

Although in the case cited, the damage done to varieties of cotton was negligible, this might not always be the case. *Cosmophila* would be capable of doing serious damage to cotton under favorable conditions. Again, work of *Cosmophila* has probably been often attributed to that of the cotton caterpillar, *Alabama argillacea*.

General Habits of the Larvæ

The larvæ, upon hatching, make their first meal of their egg shells. The newly hatched larvæ are almost indistinguishable from those of *Alabama*, being the same in size and color. In this state they are most nervous and active, and are usually found feeding on the lower side of the leaves, which they resemble so much in color that it is difficult to detect them when at rest. They stretch to their fullest extent, when resting, but are often observed in the erect position assumed by Geometrid larvæ.

According to Riley, "the principal time of feeding, as observed in my vivarium, appears to be at night, and the larvæ usually rest during the day on the lower sides of the leaves." According to the writer's observations, the larvæ feed steadily during the day, full-grown larvæ having been observed in the field in September feeding on Hibiscus buds at 10.30 a. m. in bright sunlight. The writer has also observed larvæ in many cases to eat a great deal during the day in his confinement cages. There is no doubt that the larvæ in Florida feed steadily during the day.

The larvæ in the first stage do not skeletonize the leaf in feeding as do many of the Noctuidæ but eat numerous small holes in it. The larger larvæ in feeding eat out large holes in the leaves. In the case of flower buds of Hibiscus the larvæ eat into the buds destroying their contents. This phase of injury has not been observed on any of the other food plants.

The larvæ travel with the characteristic movement of semi-loopers. As they grow larger they become more and more sluggish in their movements, usually clinging very tenaciously to the leaf. The larvæ, when full grown, often assume a very peculiar position—that of a ∩—when at rest upon either the upper or lower surface of the leaf.

Fig. I. Adult moths x 2. Fig. II. Pupa x 2. Fig. III. Work of larvæ in Hibiscus buds.

Fig. I. Larva and work on *Hibiscus mutabilis* leaf, showing also edge of leaf folded over to contain pupa. Fig. II. Photomicrograph of egg. Fig. III. Full-grown larva on okra leaf.

General Description of Stages

Egg.—The egg is circular in shape, flat below, with diameter of 0.8 mm. It is ribbed, the ribs running from the base towards the summit, many reaching only half way to the summit. This egg looks a great deal like that of *Alabama* and *Heliothis*, also very much like that of the velvet bean caterpillar (*Anticarsia gemmatilis*), although much smaller in size. The color is almost white, when first deposited, soon turning to a pale yellowish green, almost of the same shade as the lower surface of the leaf.

Larva.—The newly hatched larva is 2 mm. in length; entire body whitish; head glycerin-like in color, tips of mandibles reddish brown. After the larvæ have eaten, their bodies take on a faint greenish appearance.

According to Riley, there are six moults, making seven instars. The full-grown larva is light green in color, measuring $1\frac{3}{8}$ inches in length.

Pupa.—The pupa is 15 mm. in length, blackish-brown in color with opaque wing sheaths, the remaining portion slightly polished. The front of the head is prolonged into a short, stout, conical projection. Riley gives the following description of the tip of the last joint: "The tip of the last joint is broad and prolonged each side into a short, stout, and sharp tooth directed forward. Between these two is a pair of slender, bristle-like spines directed forward and with their tips curved in the shape of a loop; another pair of similar spines, which are directed forward and inward, are situated, one at each side, on a small projection which is armed at its edge with two large, stout, claw-like teeth, which stand at right angle to the body of the pupa."

Adult.—The male and female of this species differ greatly, the female being slightly the larger in size. The female is a bright orange yellow in color, the forewing slightly speckled with red and with slight purplish suffusion below the postmedial line, and has a wing expanse of one and a quarter inches. The male has its forewings reddish brown in color, suffused with purple gray.

Life-History

Copulation was not observed during the day and probably takes place at night. The eggs are deposited at night usually, or about dusk, singly on either the upper or lower surfaces of the leaves, the majority being deposited on the under surface. One moth in captivity deposited a scattered mass of 142 eggs on the sides of globe of the cage before dying.

Incubation takes about four days. The newly hatched larvæ, after devouring their eggshells, rest for a short time and then begin to eat the leaf.

The larval stage lasts about twenty-four days. The full-grown larva is very sluggish. It pupates, usually, by simply folding over the edge of the leaf, pupating in the recess thus made. On young okra and Abutilon leaves, it makes its pupation chamber by drawing the edges of the leaf together in such a manner as to leave a little groove in which the pupa lies ensconced. Where two leaves happen to touch or overlap, they are fastened together by a few silken threads, the larva pupating between.

Large numbers of click-beetles of two species, *Monocrepidius lividus* and *M. vespertinus*, are often found in these pupal chambers. What they are doing there is somewhat of a mystery. Experiments seem

to indicate that they act as scavengers. They would not attack living larvæ or pupæ but did in one case eat the remains of a dead pupa that had been eaten into.

The pupal stage averages six days in July. The length of this stage increases as the season advances. During August, this varied greatly, from as short as five days to as long as fourteen days. In October, the average was about nine days.

The adults copulate soon after issuing and the eggs are deposited within a few days. After all her eggs are deposited, the moth has completed the life-cycle and dies, usually within a week after her emergence.

Thus the complete life-cycle requires about thirty-four days.

Natural Enemies

The most important enemies of *Cosmophila* are the different species of wasps that prey upon them. *Polistes americanum* Fabr. was taken in the act of chewing up a full-grown larva in an okra field.

Numbers of a small hymenopteron, *Chalcis ovata*, have emerged from pupæ at different times, although the percentage of parasitization is very small. These always emerge from the upper portion of the pupa. No other internal parasites of the pupæ or larvæ have been reared.

Curious looking larvæ of a small ground beetle, *Callida decora* Fabr.[1] are often seen in the act of attacking and devouring larvæ of *Cosmophila*. These larvæ usually attack the caterpillar by the throat, holding on until it gives up the fight and succumbs. They attack the full-grown larvæ as well as the younger ones and doubtless feed on the eggs as they have been noticed to do in the case of the velvet bean caterpillar.

The larva of this beetle is 7 mm. in length. It takes about a week for the larva to mature. Upon reaching maturity, it pupates just beneath the surface of the ground or beneath leaf-rubbish. The pupa is whitish with dark-brown eyes, the body being covered with fine golden-colored hairs. The pupa stage lasts four days. The adult is a bluish-green carabid and is capable of living a month and a half without food.

Numbers of *Cosmophila* eggs were collected October 16 on leaves of Abutilon. Many of these looked bluish or black in color as if parasitized. On October 20, several minute hymenopterous parasites, *Trichogramma pretiosa* Riley, issued from the eggs.

A pentatomid, *Euthrynchus floridanus*, and a reduviid, *Zelus bilobus*, and other predaceous hemiptera without doubt are important enemies, as are also the insectivorous birds.

[1] This is an important enemy of the velvet bean caterpillar in Florida. Florida Agr. Expt. Station Bull. 130.

NOTE ON THE LIFE CYCLE OF THE SUGAR-BEET WEBWORM[1]

By H. O. Marsh, *Scientific Assistant, Truck Crop Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

In 1912 the writer published a preliminary report[2] on the sugar-beet webworm (*Loxostege sticticalis*).[3]

At the time that bulletin was prepared the details of the life history and egg-laying habits had not been definitely worked out. During the years 1915 and 1916 a series of more detailed records were obtained and the results are given herewith. The work was carried out in an open-air insectary at Rocky Ford, Col. The insects were confined in glass battery jars and the larvæ were fed with the foliage of sugar beets and lambs quarters (*Chenopodium album*).

Table I.—Records of the Generations of Loxostege sticticalis at Rocky Ford, Col., During 1915

Item	First Generation	Second Generation	Third Generation
Adults developed	June 9, 1915	July 25, 1915	Sept. 9, 1915
First eggs deposited	June 19, 1915	July 31, 1915	Sept. 16, 1915
First eggs hatched	June 22, 1915	Aug. 4, 1915	Sept. 20, 1915
First larvæ matured	July 8, 1915	Aug. 19, 1915	Oct. 27, 1915
First larvæ pupated	July 12, 1915	Aug. 24, 1915	May 10, 1916
First adults developed	July 25, 1915	Sept. 9, 1915	June 2, 1916
Egg stage, days	3	4	4
Larva stage, days	20	20	233
Pupa stage, days	13	16	23
Total duration	36	40	260

Table II.—Records of the Generations of Loxostege sticticalis at Rocky Ford, Col., During 1916

Item	First Generation	Second Generation	Third Generation
Adults developed	June 2, 1916	July 14, 1916	Aug. 16, 1916
First eggs deposited	June 14, 1916	July 17, 1916	Aug. 19, 1916
First eggs hatched	June 18, 1916	July 20, 1916	Aug. 21, 1916
First larvæ matured	July 1, 1916	Aug. 2, 1916	Sept. 11, 1916
First larvæ pupated	July 5, 1916	Aug. 7, 1916	May 16, 1917
First adults developed	July 14, 1916	Aug. 16, 1916	June 11, 1917
Egg stage, days	4	3	5
Larva stage, days	17	18	265
Pupa stage, days	9	9	26
Total duration	30	30	296

[1] Published by permission of the Secretary of Agriculture.

[2] The sugar-beet webworm, Bul. 109, pt. VI, pp. 57–70.

[3] Family Pyralidæ, order Lepidoptera.

Under conditions existing in the field, a large number of the larvæ of the second generation did not pupate until May of the following year. The third generation seldom appears in sufficient numbers to cause appreciable damage.

Egg-Laying Records

Egg-laying records were obtained at Rocky Ford, Col., by isolating single pairs of moths immediately after they developed. The moths were fed with the nectar of alfalfa blossoms and the eggs were deposited on sugar-beet leaves which were placed in the cages for the purpose. The eggs were removed and counted daily. The number of eggs deposited by five females of the first and second generations were 153, 263, 377, 435 and 502, or an average of 346 eggs per female.

A detailed record of the female of one of these pairs which developed July 22 is given in Table III.

Table III.—Egg-Laying Record of a Single Female Loxostege sticticalis at Rocky Ford, Col., in 1915

Date	Number of Eggs Deposited
July 29	59
July 30	76
July 31	53
August 1	33
August 2	22
August 3	30
August 4	12
August 5	5
August 6	31
August 7	31
August 8	4
August 9	9
August 10	11
August 13	1
Total	377

The male died August 7 and the female died August 14. The egg-laying period covered a total of sixteen days.

THE HOP REDBUG (PARACALOCORIS HAWLEYI KNIGHT)[1]

By I. Myron Hawley

During the past few years hop plants in the yards about Waterville, N. Y., and especially in the vicinity of Sangerfield, have shown conspicuous injury to the foliage by perforations of the leaves and also by a stunting and deformation of the stems. In June, 1913, there were several yards at Sangerfield notably injured in this manner. Careful examination of the affected plants disclosed the presence of large numbers of red nymphs with white markings. When these yards were examined the first part of July, the nymphs were feeding on the vines and sap was flowing from the wounds which they had made. A few adults were taken at this time, which later were found to belong to the family Miridæ. Because of their striking color the writer has called them the hop redbug. Each year since 1913 the insect has increased greatly in numbers and caused more and more injury. It may now be found in yards ten miles from Sangerfield but does not appear to have reached the Cooperstown district, thirty miles distant.

The writer submitted a large series of specimens for examination to H. H. Knight, who reported them as representing a new species and described it as *Paracalocoris hawleyi*. Later the determination was confirmed by W. L. McAtee, who in addition described several varieties of the species. The drawings of the various stages are by Miss A. C. Stryke.

Nature of the Injury

The injury may be recognized by the deformed and stunted vines (Pl. 28, Fig. 1) and the irregular holes in the leaves (Pl. 28, Fig. 2). The initial injury is made evident by many light spots in the still unfolded leaves. On close examination it is found that the epidermis is broken on the under side. Later, as growth continues, a dead area is produced and, when this drops out, irregular holes result. The early work is found about the middle of June, and by the middle of July the leaves may be completely riddled.

In the later stages a nymph may feed on the vines, causing the sap to flow from the punctures. As the vine grows it will often become stunted on the side attacked, and by continuing its growth on the opposite side, a sharp bend will be formed. A plant is often weakened so that its clinging power is lost. The main stems will tend to hang down and often all the vines of the hill will slip down around the base of the pole (Pl. 28, Fig. 3). The older nymphs may also feed on the burrs

[1] Contribution from Entomological Laboratory of Cornell University.

and hop heads, but serious injury to these parts could not be detected. Pole yards are attacked worse than string yards; in string yards, the vines on the pole show more injury than those on the strings. The work of the hop redbug is similar to that described by F. V. Theobald for a related species, *Calocoris fulvomaculatus* Deg., which has caused some injury to the hop in England.

Life-History

Egg—The egg (Fig. 28) is 1.6 mm. long, .4 mm. wide and .2 mm. thick; dirty white, curved, with two prominent, pure white, incurving hooks on the micropyle end. One hook is pointed and the other is blunt at the tip. The surface of the egg is smooth and glossy.

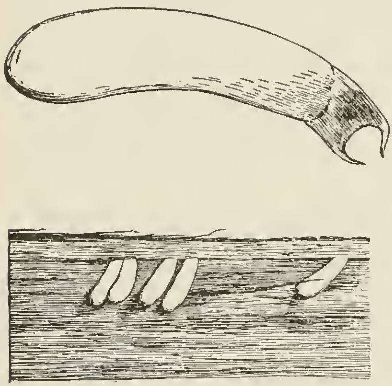

Fig. 28. *Paracalocoris hawleyi:* lower figure, eggs in bark, × 9; upper figure, one egg, more enlarged (original).

The eggs are inserted singly and in groups of two, three or four in the bark or wood of hop poles, to which they are attached by a secretion. In cedar bark the eggs are placed in a slit in the bark transverse to the grain, and can best be seen by tearing the bark lengthwise (Fig. 28). When found in this way, the otherwise inconspicuous white cap may be located on the outside. Only one egg has been found in the hard wood of a pole. This was in a crack just deep enough for the egg. Since nymphs are equally common in the spring on poles of this kind, eggs must be laid there in large numbers. The egg stage lasts from nine to nine and one half months.

Nymph.—*Stage I:* Length, 1.3 mm. (average of 10); general color light tomato red; a median, variable light line runs from near the cephalic end of the head to near the posterior end of the second abdominal segment, faint in some but in others distinctly white, bordered laterally on the thorax by clay colored patches. Antennæ with the basal segment slightly clubbed, tomato red and sparsely clothed with hairs, second segment sparsely hairy, white ($^2/_5$) and red ($^3/_5$), third segment sparsely hairy, white ($\frac{1}{2}$) and red ($\frac{1}{2}$), fourth segment densely hairy, clay color with small white spot at base. Coxa of leg is white, trochanter white, femur red, tibia with three red and three white bands of varying breadth, tarsus white with dark tip, claws dark. Each abdominal segment bears a row of dark setæ; head and thorax bear irregularly arranged setæ. Beak is white with dark tip. Venter is clay color. In a few cases the median line is wanting as well as all white bands, the insect being red with the exception of 4th antennal segments. The description is for the most typical specimens (Fig. 29).

Stage II: Length, 1.9 mm. General color, slightly darker; median line broader and more distinct; clay colored border patches indistinct; bands on antennæ and legs

1

3

2

Hop redbug work. *1, 2* Injury to leaves; *3* Hill showing vines slipping down the pole.

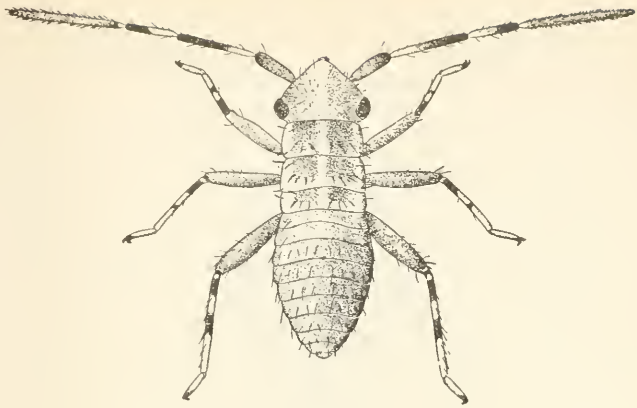

Fig. 29. *Paracalocoris hawleyi*, first stage nymph, × 30 (original).

more prominent; white spots begin to appear around setæ on abdominal segments; basal antennal segment a darker red and much more hairy; terminal segments lighter except at tip. Aberrant specimens show no median line, no white bands, faint bands on antennæ and legs or faint bands on antennæ and none on legs (Fig. 30).

Fig. 30. *Paracalocoris hawleyi*, second stage nymph, × 21 (original).

Stage III: Length 2.5 mm. General color same as previous stage; red bands on antennæ and legs much darker than body. Wing pads begin to show; white spots around setæ more distinct. Setæ longer and coarser. Some aberrant specimens as before (Fig. 31).

Stage IV: Length 3.1 mm. General color as before. Wing pads brownish and

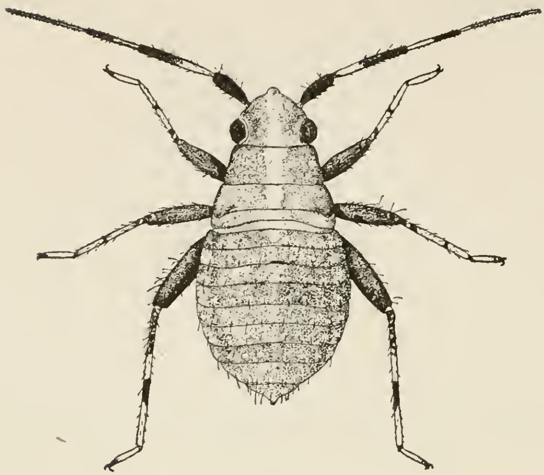

Fig. 31. *Paracalocoris hawleyi,* third stage nymph, × 17 (original).

reaching nearly to third abdominal segment; antennal segments thicker in red than in white areas. Dusky spot shows around gland between third and fourth abdominal segments. Aberrant specimens as before (Fig. 32).

Fig. 32. *Paracalocoris hawleyi,* fourth stage nymph, × 13 (original).

Stage V: Length 4 mm. There is a wide variation in color; some light red with almost transparent wing pads; some dark red with wing pads and dark spots of legs sepia. Wing pads reach almost midway between fourth and fifth abdominal segments; dusky spot around gland more prominent; two dark spots may be present on

Fig. 33. *Paracalocoris hawleyi*, fifth stage nymph, × 10 (original).

pronotum. White spots around setæ very distinct. As in previous stages there is a wide variation in markings (Fig. 33).

The data on four specimens bred in the year 1915 are given in Table No. 1.

TABLE 1.—TRANSFORMATIONS AND LENGTH OF STAGES, 1915

No.	Egg Taken	Hatch	Stage II	Stage III	Stage IV	Stage V	Adult	Egg to Adult
1....................	May 21	June 13	June 19	June 21	June 30	July 8	July 14	31 days
2....................	May 21	June 13	June 19	June 21	June 30	July 6	July 13	30 days
3....................	May 6	June 15	June 20	June 24	June 30	July 6	July 13	28 days
4....................	May 6	June 10	June 15	June 22	June 30	July 7	July 12	32 days

Average; 30.1 days.

Breeding was carried on in petri dishes in a well ventilated, unheated field laboratory. Pieces of bark with eggs were placed in the dishes. These were examined and after hatching fresh food was added each day.

ADULT.—The adult is about 6 mm. in length, fusco-piceous to piceous with hemelytra sordid hyaline or pale yellowish and cuneous reddish. Pubescence is sparse.

Technical descriptions of the species and four varieties are published in the December (1916) issue of the *Annals of the Entomological Society*

of America by W. L. McAtee who examined the material sent him by H. H. Knight. Of these four varieties, *Paracalocoris hawleyi* var. *hawleyi* and *P. hawleyi* var. *ancora* are the common forms on the hop. The former has a pale lateral stripe on the corium (Fig. 34), which is not present on the latter. *P. hawleyi* var. *ancora* is much more numerous than the other form (Fig. 35).

Fig. 34. *Paracalocoris hawleyi*, var. *hawleyi*, about × 7 (original).

Fig. 35. *Paracalocoris hawleyi* var. *ancora*, about × 7 (original).

Habits

The nymphs are active and, when disturbed, crawl rapidly among the leaves and vines and into the cracks of the hop poles. At rest, they may usually be found on the under sides of the most tender leaves —often five to ten on a leaf and one hundred or more to a hill. When jarred, they drop straight down to a lower leaf to which they often adhere by everting the end of the alimentary canal. They prefer the tender leaves and vines and are, therefore, in August, more numerous near the tops of the poles.

The adult, when disturbed, drops a short distance and then flies gradually downward in a zig-zag course. At rest they may be found on the vines, poles, and on the upper and under surfaces of the leaves.

Seasonal History

Over-wintering eggs are laid in hop poles from the middle of August till September, as determined by dissected specimens. These hatch the following year from June 1 till nearly the first of July. The nymphal period lasts about thirty days, adults beginning to appear about the first of July. Nearly all are winged by the first of August.

Adults may often be found in September but eventually die. There is no evidence that they survive the winter.

Natural Enemies

Predators.—The Pentatomid, *Apeteticus maculiventris* Say, is predaceous in both the nymphal and adult forms on the immature stages of the hop redbug. Eggs and nymphs of this form are common on the hop in July and August.

One of the Nabidæ, *Reduviolus subcoleoptratus* Kirby, which is present on many plants near the hop yards, has been found feeding on the nymphs of the hop redbug.

A predaceous red mite (*Trombidium* sp.) has been observed on several nymphs.

The adults, *Paracalocoris hawleyi*, of this species have been found feeding on nymphs of their own kind. Nymphs have also been found feeding on the pupa of *Ania limbata* (Geometridæ), the larva of *Lysia cognataria* (Geometridæ), the larva of *Hypena humuli* (Noctuidæ), and the pupa of *Malacosoma americana* (Lasiocampidæ).

Control

In 1915 it was decided to test a tobacco extract spray on the hop redbug. To this end nicotine sulphate (Black leaf 40), 1 pint to 100 gallons of water, with 6 pounds of soap, was applied on July 17. The material apparently killed at once. However, as fifty-six live nymphs were found on six sprayed hills on July 19 another spray was applied. This time Black leaf 40, 1 pint to 100 gallons of water with 4 pounds of soap was used. On July 20, six hills had sixteen dead and eleven live nymphs present, but on July 21 no dead nymphs could be found. This is due to the fact that the nymphs, after the spray material dries, drop off. The following experiment shows that whenever nymphs are reached they are killed. On July 19, when field experiments were carried on, forty sprayed specimens were placed in a laboratory cage. None revived. Thirty specimens sprayed with an atomizer were all killed when the same solution as used in the field was applied.

Since nicotine sulphate, $\frac{3}{8}$ pint to 100 gallons of water with 4 pounds of soap, will control the hop aphis (*Phordon humuli* Schrank), the writer tried it to see the effect on the hop redbug. Leaves with redbugs from vines sprayed in the field were taken into the laboratory. Six of fifteen specimens were alive the following day. Seven of thirty redbugs sprayed in the laboratory were alive twenty-four hours later. When the bug became attached to the glass dish by means of the solution, it was invariably killed—otherwise it often recovered. To prevent sticking, filter paper was placed in the bottom of the dish and the

bugs were sprayed with an atomizer. Six of ten were killed. It is evident that this strength is insufficient for the control of the redbug.

To be successful, spraying should be done about the third week in June, before the vines have produced large arms. Most of the nymphs will have hatched and can be reached easily at this time. Later, when the vines become dense and many have slipped down the poles, it is impossible to reach all of the bugs hidden among the mass of leaves. Poles as well as vines should be drenched, as many nymphs take refuge in the cracks and under projecting bark. Because of the agility of the bugs, it is wise to spray a hill from opposite sides at the same time when possible. Winged forms fly before they can be reached by a spray.

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AMPHISCEPA BIVITTATA SAY, IN ITS RELATION TO CRANBERRY[1]

By H. B. Scammell, *Entomological Assistant, Deciduous Fruit Insect Investigations*

Introduction

The literature on this Fulgorid is somewhat barren in so far as the subject of its life history is concerned, and the following data are set forth as a contribution dealing chiefly with biological notes made in the course of the cranberry insect investigations being conducted by the Bureau of Entomology in New Jersey. Mr. H. K. Plank assisted the writer during two field seasons and to him he is indebted for making the photographs used in illustrating this paper.

The insect has been known as the "broad winged leaf-hopper" (1)[2] but that appellation scarcely is applicable because, at least on cranberry, it is not a pest of the foliage but of the woody stems, namely, the runners and uprights. The common name which is here suggested, inasmuch as the species is associated frequently with cranberry, a cultivated crop, is the cranberry vinehopper.

Economic Importance

Dr. John B. Smith (2) recorded *Amphiscepa bivittata* Say from several places in New Jersey and made a statement to the effect that it did

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[1] Published by permission of the Secretary of Agriculture.

[2] Reference is made by number to "Literature cited," page 556.

little injury to cranberry. That conclusion is fully supported by the observations of the writer, although the species is sometimes present in such large numbers on cranberry bogs as to warrant the growers in thinking that the bugs are mainly responsible for the sickly condition of their vines.

In the past four years the insect has been taken in every cranberry section of the state and, in every instance where it was found to be abundant, the vines were in an unthrifty or dying condition due primarily to other causes such as attacks of the cranberry rootworm (*Rhabdopterus picipes* Oliv.), the cranberry girdler (*Crambus hortuellus* Hüb.), or the blackhead fireworm (*Rhopobota vacciniana* Pack.). Vines weakened by conditions of drought were found to be susceptible to its attacks also. In all cases where the bogs were in a vigorous, productive state, the species was a rarity. It is, then, not of prime economic importance as a cranberry pest but essentially one of secondary classification.

Distribution and Food Plants

It is generally well known to collectors in this country, having been recorded from practically all sections, and among its previously reported food plants are cranberry, wild balsam, golden-rod and other weeds and herbage (3). The writer has bred the nymphs from egg punctures made in the wood of the swamp blueberry (*Vaccinium corymbosum*) and from cranberry.

Life History and Habits

One generation a year is produced, hibernation occurring in the egg stage either on winter flooded bogs or those not flooded at any time.

Egg

The egg (Plate 29, fig. A) is approximately pendant shape, one end being broadly rounded, the other more tapering and terminating in a white stalk or filament which branches halfway to its tip into two forks. The surface of the egg is marked with minute, regular hexagons. Color, pale straw. Size, length, without filament, .96 mm., width .384 mm. Place of deposition: the eggs are laid in live cranberry wood and, as frequently, in pieces of dead wood lying on the bog floor. They are always found in a single row, varying in number from one or a few to twenty or more in a single piece of wood. Each egg is inserted separate from its fellows into the pith of the upright or runner (Plate 29, fig. A), the opening in the wood being made by the female with two saw-like appendages of the ovipositor. The hole is closed with the sawdust produced in this operation and the outward indications that

eggs have been deposited in a bit of wood are the tufts of fibre (Plate 29, figs. B, C) which project above each egg slit. The egg lies in a slanting position with the filament projecting out to the bark.

Submergence of the eggs by flooding the bog from the usual time in December until late in the following May does not render them inviable. Late holding of the winter flowage, say until May 30, simply retards their hatching, the nymphs appearing early in June. On dry bogs hatching begins about the middle of May. At New Egypt, N. J., four nymphs of the first instar were found May 21 on a bog which had not been winter flowed.

Nymphal Stages

Nymphs first appear on the bogs in late May but are few in number until the latter part of June and early July. The usual spring reflows, then, cannot be depended upon to clear bogs of this insect since they are given at a time when very few nymphs have hatched. The nymphs of the first and second instars are almost wholly white, while those of later instars are darker in color and bear on the body many long, white, waxy filaments (Plate 29, figs. E, F). They run with considerable speed on the vines and are strong in jumping. Probably the easiest way to locate an infestation is by use of the sweepnet, many being caught by simply sweeping the tops of the vines. The majority, however, will be found closer to the ground or on the trash beneath the vines. They derive nourishment by sucking juices from the woody parts of the vines and yet they do not injure the vines to any appreciable extent as do the toadbugs (*Phylloscelis atra* Ger.).

There are five nymphal instars and, as shown in Table 1, the nymphal period may be prolonged from early summer until mid-fall.

Table 1.—Instars of Amphiscepa bivittata Say, Pemberton, N. J., 1914

Experiment Number	1	2	3	4	5
Date of 1st molt	June 6	June 7	June 9	June 9	June 10
Date of 2d molt	June 15	June 15	June 23	June 20	June 21
Date of 3d molt	June 26	June 27	July 6	June 30	June 30
Date of 4th molt	July 15	July 24	Aug. 9	July 13	Aug. 9
Adult emerged	Aug. 6	Died Aug. 8	Died Sept. 3	Aug. 5	Died Oct. 2

An average could be taken of the duration of each instar but it will be seen that the total nymphal period of each bug was a very variable quantity and probably was greatly influenced by condition of food and environment.

The field records show that nymphs were found on the bogs from May 21 until as late as October 11.

Adult Stage

The mature vinehopper is light green, approaching yellow, in general color, with brown face and two streaks of brown, extending from the face, along the edges of the thorax and prolonged on the inner margin of each fore wing. Occasionally a pink form is found. The fore wings are very large, appearing leaflike with their prominent network of veins, and are held vertically, giving the insect a flat-sided appearance (Plate 29, fig. D). They first appear on the bogs in early August, and by mid-August outnumber the nymphs. Bog collections have shown them to be abundant as late as October 10, with the date of latest capture as October 20.

Oviposition

The earliest field collection of eggs was made August 19, but egg laying was not common until the first week of September. In the process of oviposition the female rests on the upright with head downward and abdomen curved so as to place the posterior end at right angles to the upright. Several minutes are required to saw the egg slit and make the deposition, all observations being made in late afternoon.

Seasonal History

Stage	Period of Usual Occurrence	Range in Occurrence	Usual Duration
Egg	Aug. 25–June 10	Aug. 19–June 20	9 months
Nymph (including pupal instar)	June 1–Aug. 10	May 21–Oct. 11	$1\frac{1}{2}$ months
Adult	Aug. 10–Oct. 1	July 27–Oct. 20	$1\frac{1}{2}$ months

Natural Enemies

In one of the wire screen breeding cages, stocked with thirty nymphs, a gradual diminishing in numbers took place and after a period of close watching, it was learned that a small spider had entrance to the cage and was carrying off the nymphs. Since the bogs are plentifully supplied with spiders they must be of considerable service in reducing the numbers of this species.

Some of the caged nymphs were found dead and covered with a white, fungous growth but this disease was never encountered in the field observations.

Control

Although the vinehoppers are, occasionally, abundant on some of the cranberry bogs, yet a careful study of the situation is practically

certain to reveal that the unthrifty condition of the vines, in these infested areas, is due primarily to some other agency. Such agency may be drought, unsuitable land for cranberry production, or the attack of other cranberry insects of well-known economic importance.

The remedy should, therefore, be directed at the removal of the greater pests, such as the fireworms, the cranberry girdler or the cranberry rootworm, if any of these are present, and, in general at improving conditions for growth of the vines by better cultural methods such as pruning, sanding and the application of commercial fertilizers.

If the bog can be reflowed during the summer the bugs may easily be exterminated by applying the water for twenty-four hours, preferably during a period of cloudy weather, about the 1st of August. All of the nymphs will have hatched at that time and no eggs of the new adults will have been laid. A slight wind will blow the bugs to one shore where they may be killed by the use of a kerosene burning spray torch.

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(3) Swezey, Otto H. 1904. A Preliminary Catalogue of the Described Species of the Family Fulgoridæ of North America, North of Mexico. In Ohio Dep. Agr., Div. Nurs. and Orchard Insp., Bul. 3, p. 10.

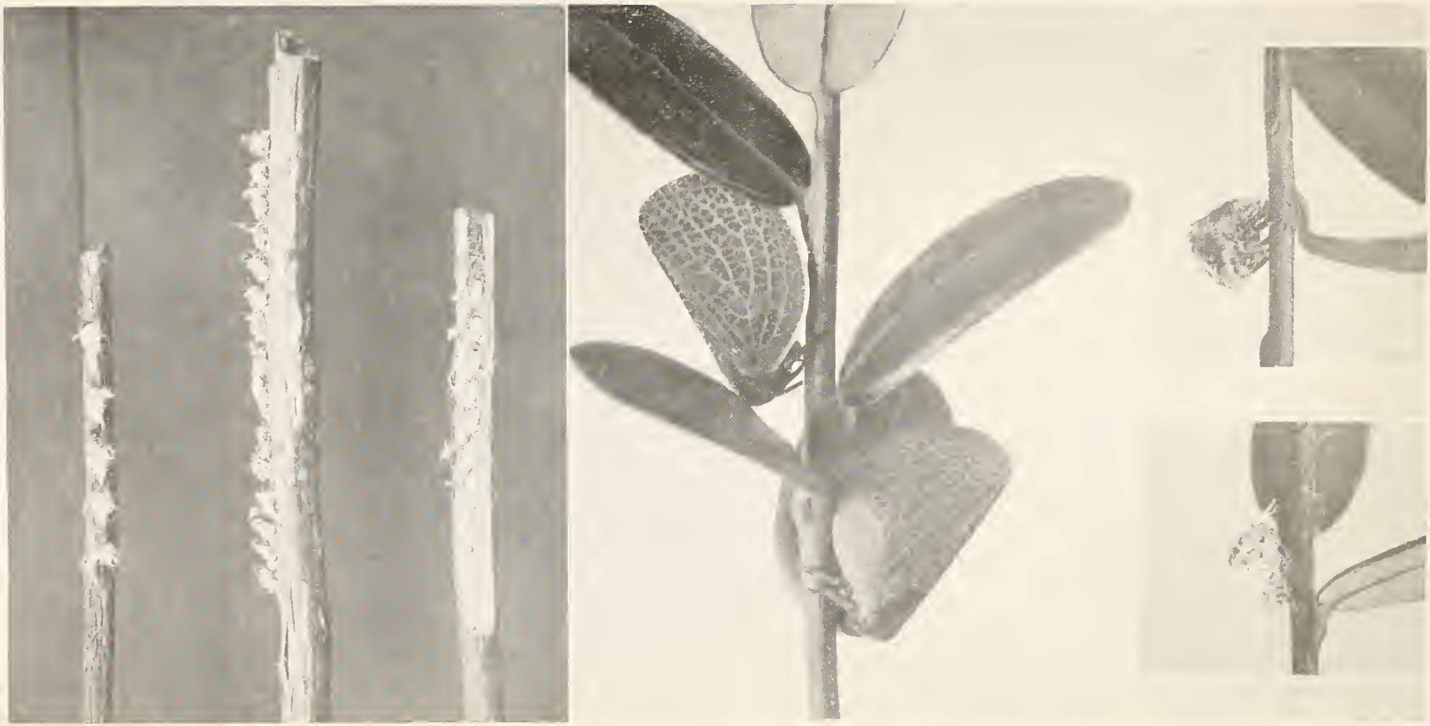
STUDIES ON THE MORPHOLOGY AND SUSCEPTIBILITY OF THE EGGS OF APHIS AVENÆ FAB., APHIS POMI DEGEER, AND APHIS SORBI KALT.

By Alvah Peterson, Ph. D., *Assistant Entomologist, New Jersey Agricultural Experiment Station*

A number of observations have been made on the structure and behavior of the outer coverings of the eggs of three species of aphides, *A. avenæ*, *A. pomi* and *A. sorbi*, found on apple trees. Some of the facts observed during the dormant period of the egg and at the time of hatching have an important bearing on certain control measures and these will be reported in brief with the expectancy of giving a more detailed account in the near future.

Explanation of Plate 29

Plate 1. *Amphiscepa bivittata* Say: A, Placement of the eggs in cranberry wood, X 7; B and C, Tufts of woody fibre above the egg punctures in cranberry wood, X 7; D, Adults on cranberry upright, X 6½; E, Pupal instar, X 7; F, Cast skin of 4th instar, X 7.



A *B* *C* *D*

By careful dissection one can distinguish three layers about the embryo: an outer, semi-transparent, brittle (soft and glutinous when the egg is deposited) layer, an inner, pigmented (glossy black), elastic layer, and an innermost layer which is thin, transparent, and surrounds the young nymph as it emerges. At the time of hatching the outer brittle layer usually splits along the dorso-mesal line before the pigmented elastic layer is ruptured by the nymph. The time interval between the splitting of the outer layer and the severing of the inner pigmented layer apparently varies with the temperature. This may be two days under greenhouse conditions or eight days when the temperature registers 30° to 40° F. All details in respect to the behavior of the layers about the egg during the hatching period have not been observed, nevertheless, it is believed that the egg goes thru a critical change a few days (possibly several weeks) before the nymph emerges and that one important step during the hatching period is apparently the splitting of the outer layer a short time before the inner pigmented layer is ruptured.

In brief the observations on the morphological structure of the egg and the behavior of the respective coverings during the hatching period shows that the egg is not a hard resistant body and that it goes thru a critical change previous to the emergence of the nymph which undoubtedly means that it is not as resistant during these changes as in the dormant period. The susceptibility of the egg and its lowered resistance near the time of hatching are further substantiated by various experiments with differences in moisture and in the use of certain contact insecticides and other chemicals.

Various experiments with the eggs of all three species under constant temperature and different controlled moisture contents show that the outer brittle layer is somewhat impervious to water under ordinary atmospheric conditions and thus it acts as a protective layer to conserve the moisture content of the embryo. Under extreme dry conditions, the outer layer is not capable of indefinitely retarding evaporation, consequently the essential water content of the embryo is lost and the egg shrivels. The inner pigmented layer is membranous and does not conserve the water content of the embryo. This is conclusively demonstrated in one experiment where the outer layer was removed from a number of normal eggs and they shrivelled completely in twenty-four hours under ordinary atmospheric conditions. The innermost, thin, transparent skin about the embryo and young nymph as it emerges does not help to conserve the water content of the embryo, so far as known.

The percentage of hatch of the eggs of *A. avenæ* and *A. pomi*, under a constant temperature of 80° F., varies with the moisture content of

the air. A brief summary of a number of experiments shows that in dry air 0 to 4 per cent of the eggs hatched, in 22 per cent moisture 0 to 12 per cent hatched, in 63 per cent moisture 20 per cent hatched and in 100 per cent moisture 36 to 46 per cent hatched. This response of the eggs to differences in moisture indicates that drought or climates with low humidity probably have an important influence on the percentage of hatch. It has been recorded for Colorado that approximately only 1 per cent of the eggs of *A. pomi* hatch while the percentage of hatch for all three species at New Brunswick, N. J., ran about 25 per cent for *A. pomi* and *A. sorbi* (mixed together) and 50 per cent for *A. avenæ* and the relative humidity for New Jersey is higher than that of Colorado.

If the eggs are weak in structure and susceptible to differences in moisture, particularly during the hatching period and possibly a few weeks previous to this time, it would seem feasible to assume that certain contact insecticides and various chemicals should effect the egg during this period. This is unquestionably the case for a number of investigators using lime-sulphur at winter strength; crude oil emulsion and other sprays have met with success in killing the aphis in the egg stage when the spray was applied late in the season just before or as the buds were bursting.

The exact physical and chemical effect of the various sprays on the egg have never been explained and, so far as known, is still more or less a mystery. Very little is known concerning the chemical structure of the egg coverings or the nature of the reactions which may occur between the egg and the insecticide used, however, some of the physical effects produced by various substances have been noted and these are discussed briefly.

In order to kill the aphis in the egg stage, the material used must prevent the nymph from hatching or it may be of such a nature as to kill the nymph as it hatches. The preventive, from a physical standpoint, may act in several ways. Any substance which will harden the outer semi-transparent shell and thus make it impossible for the nymphs to emerge would be satisfactory. Lime-sulphur apparently hardens the outer covering, at least it was noted that a large number of treated eggs did not completely collapse and in many cases the outer layer retained its normal shape while the pigmented layer and the contents of the embryo within was completely shrivelled.

Any substance which will soften or dissolve the outer layer and thus expose the pervious, inner, pigmented layer to evaporating factors such as wind, heat or low humidity would make a satisfactory control. A weak solution of crude carbolic acid will soften and apparently disintegrate the outer shell. In one experiment, the eggs of *A. pomi*

were sprayed with a 2 per cent solution of crude carbolic acid plus enough laundry soap to break the surface tension of water and then placed in a moist chamber. In an hour or more after treatment the brittle outer layer was soft and wrinkled and could be easily removed. The general decidedly glossy black appearance of all eggs treated with crude carbolic acid in the various experiments and their manner of shriveling also indicated a disintegration of the outer brittle layer.

Furthermore many substances are splendid desiccating agents and any material possessing this quality might be able to extract the water content of the ovum or embryo and thus prevent further development. Lime-sulphur, so far as observed, seems to have some desiccating effect and possibly crude carbolic may likewise act in this way.

Any toxic substance which will penetrate the egg coverings and attack the living embryo would naturally be an important agent in control and probably more direct in its effect than the foregoing ways. The extent of this penetration by various substances is difficult to distinguish and as yet no technic has been found which might be used in determining this point.

Another possible means of control would be the discovery of some chemical which will loosen the egg from the twig and cause it to fall to the ground. There is some indication that sodium-hydroxide tends to produce this result.

The more important and common contact insecticides and various chemicals have been tried on the eggs of all three species, in the greenhouse with *A. avenæ*, out-of-doors at the laboratory with *A. avenæ*, *A. pomi* and *A. sorbi*, and in the orchard (lime-sulphur, nicotine sulphate and "scalecide" only) with *A. avenæ* and *A. sorbi*. In all cases some or all of the eggs are susceptible to any contact insecticide or other chemical used in the various experiments. Of the three species, *A. avenæ* is apparently more susceptible than *A. pomi* or *A. sorbi* to the various substances.

The following table gives a brief summary of a large series of experiments conducted with various insecticides and other chemicals. The percentage of kill is figured on the basis of considering the number of eggs hatched in the check as 100 per cent. If all the eggs were taken into consideration each of the following percentages would be closer to 100 per cent; an 80 per cent kill would be 90 per cent or even greater in the average experiment.

Material Used	Percentage Killed
Lime-sulphur, 1–8 or 1–9	85%–100%
Lime-sulphur, 1–8 plus "Black-leaf 40," 1–500	97%
"Black-leaf 40," 1–500 plus laundry soap, 2 lb. to 50 gal.	45%
Laundry Soap, "Fels Naphtha," 2 lb. to 50 gal.	5%– 33%
"Scalecide," 1–15	25%– 65%

Material Used	Percentage Killed
"Mechling's Scale Oil," 1–19	79%– 90%
Sodium sulphocarbonate, 1–19	85%
Sodium chloride, 1 gram to 5 cc. water	26%– 35%
Sodium hydroxide, 2 pt. to 98 cc. water	85%– 95%
Crude carbolic acid (100%) 2 cc. to 98 cc. of solution plus soap 2 lb. to 50 gal. water	93%–100%

This representative series of results show conclusively that the eggs are susceptible to various insecticides, particularly lime-sulphur and lime-sulphur combined with nicotine. They are also susceptible to various chemicals not generally used as insecticides.

Orchard experiments with lime-sulphur, 1–9, and lime-sulphur, 1–9, combined with "Black-leaf 40," 1–500, gave good results in killing eggs of *A. avenæ* and *A. sorbi* when the spray was applied as the buds started to swell, March 31 to April 7. "Scalecide," 1–15, applied at the same time did not give a satisfactory control for the rosy aphis.

Carbolic acid and substances possessing phenol derivatives give some promise of becoming important agents in the control of aphis in the egg stage. So far as observed, crude carbolic acid in strengths up to 5 per cent acid will not injure young or old apple trees in a dormant condition. Six trees, young and old, were sprayed with a 2 per cent and a 5 per cent solution of crude carbolic plus enough laundry soap to break the surface tension of water and no injury could be found.

The greater percentage of kill with "Mechling's Scale Oil," when compared with "Scalecide," is believed to be due to the presence of phenol derivatives in the former and not due to differences in specific gravity because the two oils are practically identical in this respect. In brief, miscible oils possessing phenol derivatives give a greater percentage of kill, and this increase in kill is in all probability due to the phenol or cresols.

Scientific Notes

New Tick Records for Minnesota. In December, 1915, a male *Ornithodoros tolaje* was sent to this office from Le Sueur, Minn. It had been found in the shop of a glazier in that town. The only source from which the tick could have come was hay in which it was stated glass had come packed from Oklahoma. The shop was upstairs in a flat roofed building, with no attic. No birds, bats or other animals were there. In April, 1916, a second specimen was sent in from the same source. This tick has been reported formerly from Florida, Texas and California.

A new tick has become established in Minnesota, *i. e.*, *Dermacentor albipictus.* Elk brought two or three years ago from Montana and placed in the game reserve at Itasca Park have been badly bothered with these ticks ever since their arrival. They became so bad this last spring as to require spraying of the animals. It is supposed that they were brought here with the elk as they have never previously been found in Minnesota.

C. W. Howard.

A Suggestion for the Destruction of Cockroaches. The recent successful attempts to destroy bedbugs in dwelling houses by superheating makes the possibility of killing cockroaches (*Blatella germanica*) by the same system seem feasible. A number of experiments have been carried out by the writer to ascertain what degrees of heat were fatal to them. It was found that temperatures below 120° F. were variable in their effect, but exposure to a temperature of 122° F. to 140° F. for twenty minutes destroyed 100 per cent. Many difficulties are involved in employing this method, owing to the habit of the cockroach of hiding in cracks, between walls, etc.

On the other hand cold is also very destructive to the "Croton Bug." We find that exposure to 24° F. for three hours killed 100 per cent, to 18° F. for twenty minutes killed 100 per cent, 10° F. for five minutes killed 100 per cent, to 0° F. for five to ten minutes killed 100 per cent. The application of cold for this purpose would meet with more difficulties than would that of heat.

The writer has not yet had the opportunity to make a practical test based on these observations, but offers the suggestion for what it may be worth.

C. W. Howard, *University Farm, St. Paul, Minnesota.*

27 September, 1917.

Occurrence of a Fungus-Growing Ant in Louisiana.[1] The presence of the fungus-growing ant, *Atta texana* Buckley, in Louisiana was first brought to the writer's attention on November 8, 1914. This was at Glenmora, Rapides Parish, in the long-leaf pine hills about twenty-five miles south-southeast of Alexandria. Specimens were collected and the identification afterwards verified by Dr. W. M. Wheeler. Farmers in the parish have more recently complained of injury to cultivated crops by the ant.

The species has hitherto apparently been recorded only from Texas. The following extract from a letter from a correspondent in Glenmora indicates that they have been present in that section for a long time. The correctness of the tradition which he mentions is, however, as Doctor Wheeler has stated in a letter to the writer, rather doubtful because of the improbability of queens, without which the species could not become established—being so transported. The correspondent writes as follows:—"There is an old tradition to the effect that the Spaniards brought them to this country from Texas. The old trail leading from San Augustine, via Natchitoches, to New Orleans passed through this country, and these ants may be found on most of the high sandy land on each side of this trail."

Thomas H. Jones, *Entomological Assistant,*
Bureau of Entomology, U. S. Dept. of Agriculture.

Some Sunflower Insects. *Weevil Attacks.*—Mrs. Cockerell noticed last September that weevil larvæ (*Desmoris*) were able to induce growth in unfertilized seeds. Bagged sunflower heads which were not fertilized produced no seeds, as the plant is not fertile with its own pollen. The ovaries shrink and show no development, but in one such head eleven ovaries contained weevil larvæ, and in spite of lack of fertilization were large and swollen, larger than the normal seeds. We are reminded of the experiments of Loeb, in which unfertilized eggs were caused to develop by various stimuli.

Systena hudsonias Forst, (det. Schwarz) was found eating leaves of *Helianthus annuus* at Boulder, July 22, 1915.

Autographa biloba Steph. has been bred from leaves of *Helianthus* at Montreal (Winn in litt.).

[1] Approved by the Secretary of Agriculture.

Loxostege coloradensis G. & R. (det. McDunnough) was bred at Boulder, Sept. 12, from a larva folding leaves of *H. annuus*. The larva is very pale yellowish, with a narrow greenish-grey dorsal band and a broad dilute grey band on each side; the tubercles are conspicuous and jet-black, each with one long hair. Head clear pale reddish.

T. D. A. Cockerell.

Asphondylia websteri n. sp. The occurrence of a European species in an isolated area in the southwestern United States appeared remarkable, though prior to the rearing of a large series of this fly by Mr V. L. Wildermuth at Tempe, Arizona, in 1917 it was impossible to more than question the earlier identification of this insect as the European *A. miki* Wachtl. The American form is a decidedly smaller, darker and more naked species. The general characteristics of the insect have been admirably given in the below cited circular by Professor Webster, to whom we take pleasure in dedicating this species.

Male: Length 2.25 mm. Antennæ nearly as long as the body, practically naked, dark brown; 14 segments, the fourth cylindric, with a length about six times its diameter and moderately stout, low circumfili. Palpi; first segment short, subquadrate, the second with a length over four times its diameter, the third a little shorter than the second, narrowly oval. Eyes large, black. Mesonotum dark reddish brown, practically naked, there being only a few short, sparse, yellowish scales and no well marked submedian lines. Scutellum reddish brown, postscutellum yellowish brown. Abdomen mostly a dark slaty brown, the genitalia reddish brown. Wings hyaline, almost naked, costa a light strawy brown. Halteres mostly pale yellowish, slightly fuscous subapically. Coxæ dark reddish brown. Femora, tibiæ and tarsi mostly a pale yellowish brown, the tarsi slightly darker. Genitalia; basal clasp segment short, stout, terminal clasp segment very short, stout, irregularly and strongly bidentate. Dorsal plate long, broad, broadly and triangularly emarginate, the divergent lobes narrowly rounded. Ventral plate shorter, deeply and roundly emarginate, the short heavy lobes obliquely truncate. Style moderately long, stout, narrowly round apically.

Female: Length 2.25 mm. Antennæ about $\frac{3}{4}$ the length of the body, practically naked, dark brown, the fourth segment with a length about six times its diameter, the fifth with a length about five times its diameter, the twelfth and thirteenth segments each with a length about equal the diameter, the fourteenth reduced, cuboidal. Palpi; first segment short, quadrate, the second with a length fully twice its diameter, the third about twice the length of the second, more slender. Mesonotum shining dark brown with a very few short, yellowish hairs. Scutellum yellowish, postscutellum yellowish orange. Abdomen a shining dark brown, reddish brown apically. Coxæ dark brown, legs mostly a strawy brown. Claws rather long, somewhat slender, the pulvilli shorter than the claws. Ovipositor when extended nearly as long as the thorax and abdomen. The dorsal lobes well developed. Other characteristics practically as in the male. Type Cecid. a2420.

1912 Webster, F. M. The Alfalfa Gall Midge, U. S. Dept. Agri., Bur. Ent., circ. 147, p. 1–4 (*A. miki* Coq. not Wachtl.)

1913 Morrill, A. W. Econ. Ent. Journ. 6:194 (*A. miki* Coq. not Wachtl.)

E. P. Felt.

The Indian Meal Moth, Plodia interpunctella Hubn., in Candy and Notes on Its Life-History. During January of this year there was brought from San Francisco to the Parasitology Laboratory of the University of California a quantity of chocolate-coated marshmallow candy thoroughly infested with the larvæ of *Plodia.* The candy was badly "worm eaten" and soiled with webs and castings. The manufacturer reported considerable damage done to candy stored in fancy pasteboard boxes. Evidently the eggs of the moth had been deposited on the candy either just before packing or before the paper boxes were closed.

A number of the moths were reared from the larvæ, and several life-history experiments were undertaken.

The moths were liberated in a screened cage in which a small quantity of candy was exposed. The cage was then placed in an artificially heated insectary with temperature ranging from 22° to 26° C. Egg deposition took place at night, and the minute, glistening whitish eggs, not over twelve to fifteen per female for the cases observed, were deposited in haphazard fashion directly on the candy near the under side of each piece. The individual pieces of candy rested in fancy paper cups. The incubation period was about forty-eight hours.

The very tiny larvæ soon ate small pits in the candy and gradually became hidden within a cavern. While growth was very rapid it was found necessary to cease observations before the entire larval period was finished. By comparison with younger larvæ collected from the originally infested candy and putting the beginning and final observations on the two groups together, it becomes evident that the active feeding period probably requires not less than four weeks.

Accurate observations on the original larvæ show that the fully grown individuals leave the candy and crawl into corners or crevices where they pass a prepupal period of from nine to twelve days, during which time they spin a crude web in which pupation takes place. The pupal period requires from ten to fourteen days under the temperature conditions above noted. On the other hand the pupal period requires from twenty-four to twenty-eight days under room temperature varying from 15° to 19° C.

Thus it will be seen that the life-history of *Plodia interpunctella* requires about forty days for its completion in a maintained temperature of from 23° to 26° C., and that this insect may be of considerable importance to the candy maker.

Wm. B. Herms,
University of California.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1917

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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There is need of a new term to characterize the present day economic entomologist and at the same time give the public a more adequate idea of what economic entomology really is. It is well known that entomology relates to insect life and the man on the street is possibly willing to concede that a practical or economic entomologist gives more attention to destructive pests without admitting that the work of the latter really amounts to much. It is too often taken for granted that entomology means a frivolous mania for collecting specimens or a devotion to the more abstract phases of the science that can be satisfied with nothing less than tabulating the number and variety of hairs or scales upon an insect's legs. Both are interesting and have their place, though there is little in common between such pursuits and some of the larger problems of applied entomology now being prosecuted in various parts of the country or demanding the attention of full-sized men.

Some years ago one of our colleagues became obsessed with the idea that it was practical to rid a state of mosquitos. He did not live to see the full realization of his hopes. His faith has been amply justified by subsequent developments. It was something more than the world recognizes as practical or economic entomology. A small weevil invaded the cotton fields of the South, causing great losses and threatening grave disaster. Field investigations in the very forefront of the invasion changed extensive losses to efficient control and in working out the larger aspects of this problem, we have much not ordinarily

comprehended under economic entomology. There was a similar invasion of New England by a pest bringing death and destruction to much of the best timber, and here again a study of the broader aspects of the problem resulted in satisfactory control by methods not commonly associated with the term economic entomologist.

Fundamentally, these are engineering problems, Entomological Engineering, if you please, and we believe that the more general use of some such term would assist materially in giving this branch of natural science the standing it richly deserves. Entomological Engineer would be no misnomer, since Webster defines engineering as: "The science and art of utilizing the forces and materials of nature." We have forest engineers, why not entomological engineers? These larger phases of natural history are becoming more insistent in their demand for solution and they can be handled only as adequate provision is made. The stake is larger and the issues more vital under the compelling necessity of war. Are we to meet the situation? Can we rise to our opportunities and demonstrate as never before the possibilities of knowledge directed to the control of injurious and dangerous insects?

The establishment of an absolute quarantine against the importation of all plants, more especially nursery stock, appears like an easy and effective method of preventing the further introduction of injurious insects and plant diseases. The experiences of this country would certainly justify such action in sections of the world where the native fauna and flora had been disturbed to only a very slight extent by the introduction of species with their enemies and diseases. This does not necessarily follow in the case of a country in close touch with other parts of the world and which has been importing large amounts of stock annually for a series of years. We already have many of the more important enemies of standard fruits, like the apple, and the adoption of such drastic measures should be preceded by a careful weighing of the benefits and losses consequent upon such action. It might be possible to exempt cosmopolitan plants, especially those in regions where they have been grown and shipped for years, and thus secure maximum benefit and minimum interference with commerce. It is the novelties, the less widely distributed plants, which are potentially the more dangerous, and these might well be brought in under governmental agencies charged with the employment of every reasonable precaution to prevent the introduction of dangerous insects and plant diseases. It may not be easy to distinguish between the two classes of plants and yet an absolute quarantine would be farther than many Americans would care to go.

Current Notes

Conducted by the Associate Editor

The cotton boll weevil has recently been found in Beaufort County, South Carolina, by Prof. A. F. Conradi.

Mr. H. H. Knight, investigator in entomology, Cornell University, is about to enter the United States military service, Aviation Corps.

Mr. J. W. Bailey, Bureau of Entomology, formerly located at Tempe, Ariz., has resigned from the service to accept other work.

Mr. Clarence R. Cleveland, assistant, has been promoted to instructor in economic entomology at the New Hampshire Agricultural College and Station, Durham, N. H.

Mr. Allan H. Jennings of the Bureau of Entomology has been commissioned a first lieutenant in the Sanitary Corps of the United States Army.

Under the Food Production Act, the Secretary of Agriculture has authorized the appointment of six additional men in the Bureau of Entomology for extension work in beekeeping.

Miss Margaret L. Moles, a post-graduate student at Cornell University, has been appointed insect delineator in the Bureau of Entomology to fill the vacancy caused by the death of Mr. J. F. Strauss.

Dr. W. J. Holland is chairman of the committee on arrangements for the coming meeting of the American Association for the Advancement of Science, to be held at Pittsburgh, Pa., December 28 to January 2.

Prof. Edwin C. VanDyke of the University of California, a specialist on the Coleoptera, and Prof. J. Chester Bradley of Cornell University, a specialist on the Hymenoptera, have exchanged work for the present college year.

The Federal Horticultural Board announced a public hearing at Washington on November 20, regarding a proposed quarantine to prohibit the importation of sweet potatoes and yams, on account of sweet potato weevils, *Cylas* spp., and the sweet potato scarab, *Euscepes batatæ*.

Mr. M. E. Kimsey, formerly deputy state entomologist of Indiana, has accepted the position of special field agent in the Bureau of Entomology, Cereal and Forage Crop insect Extension work, under the immediate supervision of Dr. A. W. Morrill, state entomologist of Arizona.

Messrs. Dwight Isely and H. C. Ingerson, Bureau of Entomology, have recently completed an insect survey trip in the orchard section of Arkansas, Missouri and Kansas. This trip was made in connection with the recently established laboratory for deciduous fruit insect investigations at Bentonville, Ark.

The following transfers have been made in the Bureau of Entomology: H. L. Dozier, Tempe, Ariz., to Charlottesville, Va.; C. C. Hill, Knoxville, Tenn., to Carlisle, Pa.; J. R. Horton to Wellington, Kans.; A. B. Champlain, Washington, D. C., to Lyme, Conn.; A. D. Borden to Upland, Cal.

The Food Production Act passed by Congress appropriates $441,000 for combating insect pests and plant diseases and the conservation and utilization of plant products. A portion of this has been allotted to the Bureau of Entomology for extension work in the various states.

In Idaho the legislature, at its last session, made appropriations to the University and Station, including $4,000 for the further study of insect pests troublesome to alfalfa and clover seed producers, and $1,200 for emergency calls in the investigation of plant diseases, insect pests and soil troubles.

A conference was called for November 12 and 13 at Pittsburgh, Pa., of the Committee on the Suppression of the Pine Blister Rust in North America. The meeting was held in the rooms of the Chamber of Commerce, and special attention was given to proposed legislation to prohibit the importation of plant materials.

The Florida Entomological Society, organized less than two years ago, now has sixty-one members and publishes a quarterly journal called *The Florida Buggist*, two numbers of which have appeared, one on June 21, and the other on September 21. The editorial staff is as follows: editor, Prof. J. R. Watson; associate editor, Dr. E. W. Berger; business manager, K. E. Bragdon.

The following appointments have recently been made in the Bureau of Entomology: G. H. Vansell, assigned to Tempe, Ariz. For extension work—Scott Johnson, A. L. Ford, Kansas; M. E. Kimsey, Arizona; H. H. Fort, Missouri; C. W. Curtin, C. F. Stiles, C. H. Gable, at large; J. M. Robinson, O. L. Snapp, E. P. Barrios, G. Garb, S. W. Frost, H. N. Gellert, H. K. Laramore, H. J. Ryan, F. D. Young and William R. Martin.

Mr. J. L. E. Lauderdale, formerly of the United States Bureau of Entomology, stationed at Baton Rouge, La., is now located at Yuma, Ariz., as field assistant entomologist, and Mr. D. C. George, formerly of the Washington State College, has also been added to the staff of the Commission of Agriculture and Horticulture as plant pathologist, under the administrative supervision of Dr. A. W. Morrill, state entomologist.

Mr. M. A. Yothers, formerly assistant professor of entomology in the Washington Agricultural College, has been appointed to the position of specialist in apple insect investigations, Bureau of Entomology, and will undertake a thorough-going study of the codling moth and other orchard pests in the Rogue River Valley, Oregon, in coöperation with the Oregon Agricultural Experiment Station.

An entomological section has just been formed in the Lorquin Natural History Club of Los Angeles, Cal. The first meeting was held at the public library on September 15, at which fourteen were present. Dr. J. A. Comstock was elected chairman, and Mr. Raoul M. May, secretary. The section meets at the public library in the evening of the third Saturday of each month and all entomologists are invited to attend the meetings.

Mr. E. R. Sasscer, Bureau of Entomology, reports that the Florida fern worm (*Callopistria floridensis*) has recently appeared on species of *Adiantum* in a greenhouse in St. Joseph, Mo., and to date has practically ruined three crops of ferns when they were ready for marketing. This pest was in all probability introduced into Missouri in a shipment of ferns received from New Orleans, La., last spring. The Florida fern worm is gradually being distributed from state to state on ferns, and for the past two years it has been responsible for considerable injury to these plants in Anacostia, D. C.

On September 14 a conference was called by Dr. L. O. Howard at Riverton, N. J., to carefully investigate the present status of the recently introduced Japanese beetle, *Popillia japonica*. Those in attendance at the conference were: Dr. L. O. Howard, Prof. J. G. Sanders, Dr. T. J. Headlee, H. B. Weiss, E. R. Sasscer, William O. Ellis

and Dr. A. L. Quaintance. It was found that the beetle had established itself over an area of some 500 or 600 acres, being quite abundant in certain parts of this area. Thorough-going life history work is under way under the immediate direction of Mr. William O. Ellis, in coöperation with the New Jersey Agricultural Experiment Station. Special effort will be made to confine the insect to its present area of distribution and eradication measures will be undertaken if further study of the insect indicates such action as at all likely to be effective.

On October 4, a conference of southern entomologists was held at New Orleans to discuss the pink bollworm situation. It was attended by W. E. Hinds, Alabama; Franklin Sherman, Jr., North Carolina; E. L. Worsham, Georgia; Wilmon Newell, Florida; E. E. Scholl and E. L. Ayers of the Texas Department of Agriculture; Prof. S. W. Bilsing of the Texas A. and M. College; W. R. Dodson, director of the Louisiana Experiment Station; B. R. Coad, Tallulah, La.; T. E. Holloway and W. D. Hunter of the Bureau of Entomology. After a full discussion a resolution was passed to the effect that unless further infestation is found at some point in Texas it is unnecessary for any of the southern states to modify their present quarantine regulations or promulgate new ones.

Mr. F. C. Craighead, Bureau of Entomology, spent the first two weeks of September in the vicinity of Kansas City, Mo., and Colorado Springs, Col. In the former locality he investigated the cause of the dying oaks. A large percentage of the oaks in that locality (reported generally also through the state) is dying slowly from year to year. The insect associated with these dying trees, and no doubt responsible for the death in a large measure, is the two-lined chestnut borer (*Agrilus bilineatus*). The beetles attack the top, killing this in one or two seasons and frequently kill the entire tree. At Colorado Springs, Mr. Graighead studied the work carried on at the station for the past two years in the control of poplar borers (*Saperda calcarata* and *Xylotrechus obliteratus*). At higher elevations entire stands of poplars have been destroyed by these insects.

Mr. R. S. Woglum, Bureau of Entomology, reports that on September 17 a man was killed at Upland, Cal., by liquid hydrocyanic acid while making preparations to fumigate citrus trees. The accident was due either to some defect in the apparatus or possibly to carelessness. This seems to be the first fatality which has occurred in some thirty years of orchard fumigation in California. Anhydrous liquid hydrocyanic acid for fumigation purposes was apparently first employed by Charles W. Mally in South Africa in 1915 and was subsequently investigated by private concerns in Southern California. As the result of these investigations, considerable interest has been awakened among California growers and fumigators, and at the present time a number of outfits are using this method of fumigation. Just what effect the unfortunate fatality referred to above will have on this method of fumigation in California is problematical. It may result in the return to the pot or machine method of generation. While it may be that the use of liquid hydrocyanic acid has advantages over the method of fumigation standardized by Mr. Woglum, it must be remembered that its practical value can only be established by a thorough investigation by those familiar with the subject, and commercial work should not be undertaken by those unacquainted with the poisonous nature of liquid hydrocyanic acid which volatilizes with great rapidity. A thorough investigation of this subject by Mr. Harry D. Young, who is a chemist as well as a practical fumigator, is now in progress under the direction of Mr. Woglum.

Mailed December 15, 1917

INDEX

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